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ERRATA

Page 6 line 24 for "*annulatus*" read "*annulata*"

,, 83 line 18 for di(p-chlorophenyl)-ethinyl-carbinol" read "di(p-chlorophenyl)-ethynyl-carbinol"

,, 101 last line for "but decrease" read "but no decrease"

,, 110 8 lines from end for "500 dissected" read "out of 500 dissected"

,, 112 line 8 for "*Anonpheles*" read "*Anopheles*"

,, 116 20 lines from end for "Labanon" read "Lebanon"

,, 124 8 lines from end for "cover" read "covered"

,, 164 line 2 for "phosphorodithioate]" read "phosphorodithioate)]"

,, 187 lines 20–21 for "injected into fresh mosquitos, and after 11–13 days suspensions of the latter mosquitos were injected into fresh monkeys." read "were injected into fresh monkeys 10–14 days later"

COMMONWEALTH INSTITUTE OF ENTOMOLOGY.

REVIEW

OF

APPLIED ENTOMOLOGY.

SERIES B.

Vol. 47. 1959.

ŁUKASIAK (J.). **Zmienność morfologiczna jaj i indeksu łuskowego** *Anopheles maculipennis* **Meig., 1818.** [Morphological Variability of Eggs and of the Scale Index in *Anopheles maculipennis* Meig., 1818.]—*Acta parasit. polon.* **5** fasc. 27 pp. 599–612, 1 graph, 29 refs. Warsaw, 1957. (With a Summary in English.)

To investigate the forms of *Anopheles maculipennis* Mg. present in the Warsaw area, measurements were made of at least 15 scales of the radial vein of the wings of 293 females and two males [*cf. R.A.E.*, B **38** 39] and eggs laid by these and other females were examined. The female mosquitos were divided into ten forms and three groups, *maculipennis* (*typicus*), *messeae* Flni. and one approximating *atroparvus* van Thiel, on the basis of the eggs, though differences in size, shape and design were observed, not only among the eggs of the various forms, but also among those laid by individual females. The scale indices (length/width of the scales) were 10·7 in the form approximating *atroparvus*, 9·37–10·05 in the seven grouped as *messeae*, and 8·84 and 8·75 in the two grouped as *typicus*. The two males (*typicus*) had an index of 7·95. The considerable morphological differences observed in this work are attributed to the results of hybridisation between races in the Warsaw area, but the influence of environment during development of the immature stages may also be a factor.

ROMAN (E.), VIOLET (P.) & RINAUDO (E.). **Destruction par l'E.P.N. des larves du moustique citadin,** *Culex pipiens autogenicus*.—*Bull. Soc. Path. exot.* **49** (1956) no. 4 pp. 661–667. Paris, 1957.

Synthetic insecticides are used in Lyons to control larvae of *Culex pipiens molestus* Forsk. (*autogenicus* Roub.) in septic tanks. They have to be applied in emulsified form to reach all the compartments of sectional installations, which are common there. DDT was used with success for several years, but the larvae then became resistant to it, and phosphorus compounds were tried. Malathion did not prove effective, but very promising results were obtained with EPN [O-ethyl O-p-nitrophenyl phenylphosphonothioate] in the form of a 25 per cent. wettable powder and a 20 per cent. emulsion concentrate. A preliminary test showed that the

powder was effective against larvae of a strain normally susceptible to DDT, and subsequent ones (from 1954 onwards) were made with a strain to which a DDT-resistance coefficient of about 25 was assigned. Batches of 20 fourth-instar larvae were used, and the concentrations of powder or concentrate to which they were exposed are shown below by figures expressing the amounts of actual EPN per hundred million parts water. The powder killed all larvae in two days at 0·5, but allowed some to survive for three days or more at 0·2. Larvae that pupated during the exposure gave rise to adults. The emulsion killed all larvae in 24 hours at 1 and 19 out of 20 at 0·5, and all in three and five days at 0·2 and 0·1, respectively, but appeared inactive at 0·05. In water containing 0·075 per cent. human faecal matter, the emulsion retained its toxicity for seven days at 1, and the powder did so for at least ten days at 2 and for at least five but not ten days at 1. To estimate the possibility of treating series of tanks, by introducing EPN through the lavatory pan, tests were made with water containing faecal matter in three communicating vessels simulating the compartments of a sectional installation. The emulsion killed all larvae of the resistant strain in four days in all the vessels at 2; at 1, it killed all larvae of a slightly less resistant strain in three days in the first two vessels, but not in the third. The powder at 1 or 2 was not effective in the third vessel.

Further tests showed that EPN at 20 usually had no adverse effect on liquefying aerobic or anaerobic bacteria, so that its use at larvicidal concentrations would not impair the functioning of the septic tanks.

TOUMANOFF (C.) & SIMOND (M.). **Quelques observations sur la faune culicidienne de la Basse Guinée (Conakry et Presqu'île de Kaloum) (Saison sèche de l'année 1956).**—*Bull. Soc. Path. exot.* **49** (1956) no. 4 pp. 667–674, 6 refs. Paris, 1957.

The town of Conakry occupies an island at the extremity of the peninsula of Kaloum in French Guinea, connected with the mainland by an artificial isthmus. The peninsula comprises its suburbs and a sparsely populated zone with a few villages and banana plantations. There are few potential breeding places for mosquitos in the town, apart from a small number of septic tanks, and a mosquito problem seldom arises there. An Anopheline larval survey in the suburbs and environs of the villages up to 15 miles away in February and March (dry season) 1956 showed the presence of *Anopheles coustani* Lav., *A. obscurus* (Grünb.), *A. longipalpis domicolus* Edw., *A. funestus* Giles, *A. hargreavesi* Evans, *A. hancocki* Edw., *A. moucheti* Evans, *A. sergentii macmahoni* Evans, *A. gambiae* Giles, *A. gambiae melas* Theo., *A. squamosus* Theo., *A. rufipes* (Gough) and possibly *A. rhodesiensis* Theo. Some of these and also larvae of *A. brunnipes* (Theo.), *A. flavicosta* Edw. and *A. hancocki masseguini* Hamon were found in November and December. The larvae of most of the species were found in a marshy area fed by a small spring and consisting of a few clear sunlit pools of fresh water (30 mg. sodium chloride per litre) with clay bottom and rich and varied vegetation. The neighbouring village was highly malarious. This focus provided a valuable means of passing the dry season for the species concerned. Some larvae, notably *A. coustani*, *A. hancocki* and *A. hargreavesi* were also found in permanent breeding places (irrigation channels and streams in a banana plantation) and *A. gambiae* was found in stagnant water about 15 miles from Conakry. Apart from two females of *A. coustani* taken in an isolated dwelling in the bush where there were no livestock, the only adults taken in day and night catches were *A. gambiae*, which showed

semi-endophily. Females were taken in the open attacking man or resting on the exteriors of huts at night and in small numbers inside huts by day. Females taken both indoors and outdoors contained human blood, but none was gravid. This suggests at least partial aestivation. Other mosquitos taken all belonged to the genus *Culex*.

Adam (J. P.), Rickenbach (A.) & Hamon (J.). **Présence en Afrique Occidentale Française de** *Anopheles macmahoni* **Evans 1936.**—*Bull. Soc. Path. exot.* **49** (1956) no. 4 pp. 674–676, 1 fig., 4 refs. Paris, 1957.

A long series of larvae taken in residual pools and muddy puddles in the Koriba district of Haute-Volta, French West Africa, and pupae and adults reared from them proved on examination to be *Anopheles sergentii macmahoni* Evans. Variations noted in the chaetotaxy of the larvae and pupae are described.

Adam (J. P.) & Mattingly (P. F.). **Note sur la morphologie et la biologie d'***Anopheles* (*Neomyzomyia*) *smithi* **var.** *rageaui* **Mattingly (P. F.) et Adam (J. P.) 1954.**—*Bull. Soc. Path. exot.* **49** (1956) no. 4 pp. 734–747, 5 figs., 9 refs. Paris, 1957.

As a result of the collection and rearing of additional material in the type locality in the French Cameroons, descriptions are given of the male, female pharynx and immature stages of *Anopheles rageaui* Mattingly & Adam, and it is considered a variety of *A. smithii* Theo. It was originally described from a single female taken in an underground gallery at Oliga near Yaoundé [*R.A.E.*, B **43** 80], and larvae were found in very shallow water on the cement floor of this gallery. The water was often a mere film over the mud, and laboratory tests showed that the larvae can survive drying for several hours. Development from egg to adult in the laboratory required 40 days in continuous darkness, resembling that of the gallery, and 23 days under normal conditions of light.

The adults were found in and near the gallery and also, in some numbers, near a village about 12 miles away, where they were associated with an overhanging cliff, rocks and the entrance of a small cave. They may well have been breeding in water that trickled over parts of the rocks. The adults were most often taken at Oliga in late December and early June. They showed no tendency to attack man and were never found in occupied huts, but four females and two males were taken in an unoccupied brick building.

Adam (J. P.), Hamon (J.), Rickenbach (A.) & Lips (M.). **I. Description du mâle et du pharynx de la femelle d'***Anopheles brohieri* **Edwards 1929 et** *A. hancocki* **var.** *masseguini* **Hamon 1954. II. Étude des affinités existant entre** *Anopheles hancocki*, *A. hancocki* **var.** *masseguini*, *A. brohieri*, *A. theileri*, *A. seydeli*.—*Bull. Soc. Path. exot.* **49** (1956) no. 4 pp. 747–758, 5 figs., 4 refs. Paris, 1957.

Descriptions are given of the male and the pharynx of the female of *Anopheles hancocki* var. *masseguini* Hamon and *A. brohieri* Edw. [*cf. R.A.E.*, B **44** 140]; and it is concluded, from a study of specimens of the forms concerned, that *A. hancocki* Edw., *A. seydeli* Edw. [*cf.* **29** 201] and *A. brohieri*, all of which were described as varieties of *A. theileri* Edw. [**18**

43] and have subsequently been accorded specific status, are clearly distinct from *A. theileri* but so closely allied to one another that *A. seydeli* and *A. brohieri*, as well as *A. h. masseguini*, should be considered varieties of *A. hancocki*. From descriptions of *A. theileri* var. *septentrionalis* Evans [**23** 58], it is further concluded that *septentrionalis* is a synonym of *brohieri*.

Webbe (G.). **The Action on Fish of several chlorinated Hydrocarbons when used as Larvicides.**—*Ann. trop. Med. Parasit.* **51** no. 3 pp. 264–270, 11 refs. Liverpool, 1957.

Farming of fish of the genus *Tilapia*, by the construction of fish-ponds or the stocking of impounded water, has increased considerably in many parts of Africa in recent years but often conflicts with the control of Anopheline larvae. The action of larvicidal formulations of DDT, BHC and dieldrin on three species of *Tilapia* (*melanopleura*, *macrochir* and *pangani*) was therefore investigated in Tanganyika in experimental ponds into which partly grown fish were introduced before treatment. The three species were equally susceptible to a 5 per cent. solution of DDT in oil, which caused 50 per cent. mortality at 1 quart solution per acre in three weeks; the oil alone caused no mortality even when applied at 4 quarts per acre weekly for three weeks. Granules containing 2 per cent. dieldrin were tested at rates of 1, 2, 5 and 10 lb. per acre. Five weekly applications at 1 or 2 lb. caused no mortality, but the percentages of *T. macrochir*, *T. melanopleura* and *T. pangani* dead in three weeks after single applications at 5 and (in brackets) 10 lb. were 30 (60), 20 (50) and 0 (10). Both DDT and the higher rates of dieldrin exerted a deleterious effect on fish that had survived exposure for three weeks.

No mortality of the fish was caused in three weeks by single applications of a larvicide powder containing 3 per cent. γ BHC or an oil containing 0·25 per cent. at rates of up to 10 lb. and 1 gal., respectively, per acre, and 16 weekly applications of the powder at 1 lb. per acre did not affect breeding by the fish, the growth of their young or the flavour of fish sampled at the end of the experiment.

Turner (L. H.) & Edeson (J. F. B.). **Studies on Filariasis in Malaya: The Periodicity of the Microfilariae of** *Wuchereria malayi*.—*Ann. trop. Med. Parasit.* **51** no. 3 pp. 271–277, 2 figs., 13 refs. Liverpool, 1957.

It is shown from a review of the literature that a marked degree of nocturnal periodicity is an almost invariable characteristic of microfilariae of *Wuchereria malayi* in countries other than Malaya, and that they were nocturnal in two patients from Kedah, but could be found by day in the peripheral blood of people living in various parts of Perak. A study of their periodicity in 46 human carriers, for each of whom the results are detailed in tables, showed that it was markedly nocturnal in 26 from Penang, but much less so in 20 from East Pahang, who always had microfilariae in the peripheral blood during the day. Possible reasons for this difference in periodicity are discussed, including the species and habits of the vectors. The main vector of *W. malayi* in East Pahang and Lower Perak is *Mansonia longipalpis* (Wulp), a mosquito that bites readily in shade at any time of the day or night, but it is probable that night-biting species of *Anopheles* are the main vectors in Penang, and that the vectors in Kedah are species of *Mansonia* that seldom bite in the daytime [*cf.* next abstract]. The bearing of the difference in periodicity on the timing of blood surveys for microfilariae is noted.

Wharton (R. H.). **Studies on Filariasis in Malaya: Observations on the Development of** *Wuchereria malayi* **in** *Mansonia* (*Mansonioides*) *longipalpis*.—*Ann. trop. Med. Parasit.* **51** no. 3 pp. 278–296, 30 refs. Liverpool, 1957.

The following is based on the author's introduction and summary. Dissection of mosquitos caught in the field in Malaya has shown that *Mansonia longipalpis* (Wulp) is the major vector of *Wuchereria malayi* in the main riverine endemic areas bordering the Pahang, Barnam and Perak rivers and that *M. uniformis* (Theo.) is also an important vector there [*cf. R.A.E.*, B **27** 11], but J. A. Reid has recently found that other species of *Mansonia* are infected in endemic areas in Kedah, Province Wellesley and Penang and that *Anopheles barbirostris* Wulp and members of the group of *A. hyrcanus* (Pall.) appeared to be of greater importance than *Mansonia* in Province Wellesley and Penang. An investigation on various aspects of filariasis was begun in East Pahang in 1953, and observations were made on the development pattern of *W. malayi* in *M. longipalpis* to provide the background and standards for later experiments with mosquitos of the genus *Mansonia* as laboratory vectors of various filarial infections [*cf.* next abstract].

It was found that *M. longipalpis* is very receptive to the microfilariae of *W. malayi*. Microfilariae ingested with the blood-meal pass directly to the stomach, from which they migrate rapidly through the stomach wall to the abdominal haemocoele and thence to the thorax. Many are free in the abdomen ten minutes after the blood-meal and migration to the thorax has begun then and is almost complete after 12 hours. There is no apparent loss of microfilariae during migration or of larvae during development. Mature larvae appear on the tenth day after the blood-meal and about half the larvae are mature on the next day. From estimates of the size of the blood-meal (2–5 cu. mm., mean 3 cu. mm.) and of the numbers of microfilariae in the stomach blood immediately after feeding and in the peripheral blood of the donor at the time of feeding, it appears that *M. longipalpis* ingests more microfilariae than would be expected. Similar observations on *Aëdes aegypti* (L.) and *A. albopictus* (Skuse) showed that both species usually ingest about as many as would be expected, though a few individuals of *A. aegypti* take in much larger numbers. All species were observed to discharge droplets of clear fluid while feeding. The size of the error thus produced in weight estimations of the size of the blood-meal is unknown. The number of microfilariae found in the stomach immediately after feeding shows that, for the present, it may be assumed that *M. longipalpis* ingests the equivalent of 5 cu. mm. of blood.

Infective (mature) larvae that were transferred to the abdomen of uninfected adults of *M. longipalpis* moved actively through the mosquito and reached the head within 15 minutes. It is therefore assumed that any mosquito found in nature with infective larvae in any part of the body should be regarded as infective to man. A comparison between two very similar species, *M. longipalpis* and *M. bonneae* Edw., both usually included, as in the main body of this work, under the name *M. longipalpis*, showed that there is no difference in their susceptibility to infection with *W. malayi*. In a discussion of the effectiveness of mosquitos as vectors of filarial infection, it is suggested that the most important point about any group of mosquitos fed on a microfilaria-carrier is the number of mature larvae produced. Kartman's index of experimental infection [**43** 149] is therefore modified to become the number of infective larvae produced by a given batch of mosquitos divided by the number of mosquitos fed. A field-survey technique is described for a rapid estimation of the proportion of mosquitos that pick up an infection when feeding on an infected population. It may be of value in areas in which mass drug treatment is in use.

Wharton (R. H.). **Studies on Filariasis in Malaya: Notes on the Breeding of *Mansonia* (*Mansonioides*) Mosquitoes in the Laboratory.**—*Ann. trop. Med. Parasit.* **51** no. 3 pp. 297–300, 1 pl., 5 refs. Liverpool, 1957.

Laboratory-bred mosquitos of the subgenus *Mansonioides* of *Mansonia*, which includes the chief vectors of *Wuchereria malayi* in Malaya, are required for transmission experiments to establish the identity and importance of *Wuchereria* infections recently found there in domestic and forest animals. These mosquitos are difficult to rear [*cf. R.A.E.*, B **46** 144], and the conditions are described under which *M. uniformis* (Theo.) has been colonised and reared to the third generation in the laboratory and by which it is expected that it can be maintained. The adults mate and the females feed very readily, and oviposition can be induced fairly easily on the lower surface of leaves of a plant (preferably *Pistia stratiotes*) kept in contact with a water surface under the lamp chimney containing the mosquitos. Females normally oviposit four days after a blood-meal, but retain their eggs if they have no suitable surface for oviposition and so can be kept until eggs are wanted. The larvae are transferred on the day of hatching to an infusion 6–8 days old, of ground, dried guineapig dung in tap water at a concentration of about 6 g. dung per litre, and *Eichhornia* or another suitable water plant is introduced at the same time. The most consistent results were obtained with 200–250 larvae in 5 litres infusion in a jar 11 in. in diameter and 12 in. high, with a gauze cover. The full life-cycle occupied about a month, and development from egg to adult about 25 days. Attempts to colonise *M. longipalpis* (Wulp) and *M. annulatus* Leic. have not yet been successful, but *M. longipalpis* has been reared from egg to adult.

Lewis (D. J.). **Aspects of the Structure, Biology and Study of *Simulium damnosum*.**—*Ann. trop. Med. Parasit.* **51** no. 3 pp. 340–358, 4 figs., 2 pp. refs. Liverpool, 1957.

The following is almost entirely taken from the author's summary. Several features of the exoskeleton of the thorax and abdomen of *Simulium damnosum* Theo. are described, and changes in the appearance of the abdomen and of several internal structures are discussed. Some methods of making reconnaissance, collecting and dissecting are also described, and the use of certain physiological stages is proposed for classifying a population, most of them clearly defined because abstention from blood-sucking during the gonotrophic cycle causes the flies to appear at intervals of not less than about three days. A simple method of keeping the flies alive under field conditions is described. They are confined singly in glass tubes placed in a dish floating on water in a four-gallon tin, which is almost closed by its lid, and are provided with sugar and water and with filter-paper to rest on.

Cockburn (T. A.), Sooter (C. A.) & Langmuir (A. D.). **Ecology of Western Equine and St. Louis Encephalitis Viruses. A Summary of Field Investigations in Weld County, Colorado, 1949 to 1953.**—*Amer. J. Hyg.* **65** no. 2 pp. 130–146, 1 graph, 33 refs. Baltimore, Md., 1957.

An account is given of the chief observations made in the first five years of a long-term field investigation on the ecology of the viruses of western equine encephalitis (WEE) and St. Louis encephalitis (SLE) that was begun in 1949 in Weld County, northern Colorado. An outbreak of WEE occurred in man and horses there in 1949, and subsequent study showed this

virus to be widespread in young fowls and turkeys and in wild birds. No confirmed human cases of encephalitis were observed in 1950–53, and cases in horses were rare. However, WEE virus was isolated in 1950 from *Dermanyssus americanus* Ewing collected from the nest of an English sparrow (*Passer domesticus*) on the farm of a suspected case, and it was isolated 33 times from a total of 30,400 mosquitos in 970 pools in 1950–52, and 27 times from 15,208 in 569 in 1953. Of these isolations, 29 were from *Culex tarsalis* Coq. (which represented 23,752 of the mosquitos tested), three from *Aëdes dorsalis* (Mg.) and one from *A. nigromaculis* (Ludl.). All these isolations were in June–September except one from hibernating females of *C. tarsalis* in December 1953. The marked increase in isolations in 1953 may have been partly due to altered laboratory procedure. The virus was also isolated 23 times from nestling birds, as well as three times from adult wild birds, and some isolations were made in each of the four years.

Serological surveys showed WEE antibodies in man, horses, pigs and small mammals, chiefly hares, as well as birds and SLE antibodies in man, horses, one squirrel (*Sciurus niger*) and four nestling pigeons, but the SLE antibodies were not found in children or young horses, and their presence in the nestlings (in 1950) was the only evidence of possible activity of the SLE virus in the area during the period of the study. The findings on WEE virus increase interest in the problem of whether it is reintroduced annually from outside the area, presumably by migrating birds, or whether some means exists by which it is maintained locally in nature.

Ranzenhofer (E. R.), Alexander (E. R.), Beadle (L. D.), Bernstein (A.) & Pickard (R. C.). **St. Louis Encephalitis in Calvert City, Kentucky, 1955. An epidemiologic Study.**—*Amer. J. Hyg.* **65** no. 2 pp. 147–161, 3 figs., 12 refs. Baltimore, Md., 1957.

Details are given of an intensive study of a localised outbreak of St. Louis encephalitis that occurred in Calvert City, Kentucky, in the late summer of 1955, and included 13 cases and two deaths among a population of 1,500. It was part of a major outbreak in the lower Ohio Valley. A serological survey revealed an inapparent infection rate of 16 per cent. Analysis of the age distribution of people with recently acquired inapparent infections showed it to correspond with that of clinical cases, in whom the mean was 66 years. Mosquitos were extraordinarily abundant at the time. Frequent collections of *Culex pipiens* L. were made from fowl houses near the homes of reported cases, and SLE virus was isolated from one of them and from the blood of a wild bird (*Colaptes auratus*). Specific antibodies were also demonstrated in the sera of 19 of 35 fowls, 5 of 12 horses and mules and 11 of 17 wild birds. This is thought to be the first published record of the isolation of the virus from a wild bird in nature, though there are recent unpublished records from wild birds in California and Haiti. There was no unusual occurrence of disease in horses, mules or fowls or evidence of unusual mortality in wild birds.

Observations on the cause of the great abundance of *C. pipiens* showed that the breeding source was a four-mile slough running about one mile north-east of the town and receiving, since 1952, the inorganic wastes from plants producing acetylene. The continuous inflow and partial damming effect of road construction had converted a former low-lying drainage channel into a permanent shallow-water swamp. Control operations were directed towards the temporary elimination of larvae and adults of *C. pipiens*. Permanent and temporary breeding places, particularly the slough area, were treated with 5 per cent. DDT in fuel-oil, and outbuildings,

particularly fowl houses, with 5 per cent. DDT in emulsified solution. The measures were effective. Adequate control in subsequent seasons would require elimination of the slough.

Wiesmann (R.). **Vergleichend histologische Untersuchungen an normalsensiblen und gegen DDT-Substanz resistenten Stämmen von** *Musca domestica* **L.** [Comparative histological Investigations on Strains of *Musca domestica* L. susceptible and resistant to DDT.]—*J. Insect Physiol.* **1** no. 2 pp. 187–197, 5 pls., 12 refs. London, 1957. (With a Summary in English.)

The following is based on the author's summary. In the course of investigations on the resistance of *Musca domestica* L. to DDT, histological features of the tarsi and the abdominal cuticle of two resistant and two susceptible strains were compared. Optical examination revealed no difference in the cuticle of the tarsi of the strains, but treatment with reagents showed that the epicuticle of the tarsi of the resistant flies contained 30–40 per cent. more lipoids than that of the susceptible flies, and that their total cuticle had approximately twice as many incrustations (proteins and lipoproteins). This higher lipoid, lipoprotein and protein content of the tarsal cuticle is probably related to the greater ease with which DDT is blocked. The epidermal cells of the tarsal and other leg segments of the resistant flies (but not the susceptible ones) showed small and large vacuoles probably containing lipoids; these may not only be responsible for the high lipoid content of the epicuticle but also assist in blocking the penetration of DDT through the tarsi. On the other hand the susceptible flies secreted appreciably more lipoid-like substance from the gland present in the fifth tarsal segment than did the resistant ones, and this seems to be responsible for the higher sorption of DDT in susceptible flies. The resistant flies, unlike the susceptible ones, have fatty inclusions in the epidermal cells at the bases of the setae on the abdominal terga; these increase under the action of DDT and not only contribute to the higher lipoid content of the resistant flies but also act as a barrier against the penetration of DDT which, entering through the papillae of the setae, is dissolved in the lipoids and thus blocked.

No difference between strains was found in the tarsal nerve. This nerve was formed of two cords, which had slight swellings in each tarsal segment with the same structure as the motor ganglia of the brain and ventral chain. This arrangement can be assumed to form a small nerve reflex arc, transmitting the stimuli of the tarsal sense organs directly to the muscles of the extremities, and may explain the independent tremor of isolated extremities that is associated with DDT.

Bruce (W. N.) & Decker (G. C.). **Experiments with several repellent Formulations applied to Cattle for the Control of Stable Flies.**—*J. econ. Ent.* **50** (1957) no. 6 pp. 709–713, 3 refs. Menasha, Wis., 1958.

Since the results of tests of sprays against flies on cattle have been confused through the use of mixtures of repellents and toxicants and mixed populations of stable flies (*Stomoxys calcitrans* (L.)) and horn flies (*Siphona irritans* (L.)) [*cf. R.A.E.*, B **44** 101; **45** 142; **46** 90], the effect of repellents against *Stomoxys* only was investigated in Illinois. The repellency figures given for them are the percentages by which they reduced the numbers of feeding flies per cow as compared with the averages on control cows (untreated except where otherwise stated). In one of two tests in 1955, in

which the repellents were applied in oil solution at low dosage (20 ml. per cow), R-326 (di-n-propyl isocinchomeronate) was effective and was improved by the addition of MGK-264 [N-(2-ethylhexyl)bicyclo(2.2.1)-5-heptene-2,3-dicarboximide], but not of butoxypolypropylene glycol, while raising the concentration of butoxypolypropylene glycol from 30 to 50 per cent. in a spray containing also 2 per cent. piperonyl butoxide and 0·2 per cent. pyrethrins had little or no effect on repellency. In the other test, in which the sprays were applied at 60 ml. per cow and the weather was dry and warm, the repellency figures after 4, 8, 10 and 12 hours were 100, 99·5, 71·2 and 81·4 for 2 per cent. R-326, and 97·7, 100, 76·4 and 74·3 for 1 per cent. pyrethrins with 10 per cent. piperonyl butoxide. During 1956, the duration of repellency of oil solutions applied at 60 ml. per cow at 6.30 a.m. was estimated. The repellencies of 2 per cent. solutions after 9–12 and 28 hours were 73·2 and 75·8 for Tabutrex (di-n-butyl succinate), 63·7 and 42·1 for R-11 (2,3,4,5-bis(Δ^2-butenylene)-tetrahydrofurfural), and 68·8 and 21·5 for R-326. The weather was warm and damp, and laboratory tests had indicated that R-326 loses its effectiveness at high relative humidities. Tabutrex was not significantly more effective at 5 or 20 per cent. than at 2 per cent. In another test, however, 1 per cent. Tabutrex with 3 per cent. oleic acid gave significantly higher repellency (73) after 28 hours than 2 per cent. Tabutrex alone (51·8).

In practical tests on eight dairy farms, oil-based sprays were used daily at 0·5–1 oz. per cow for 20–30 days, and the control animals (half of each herd) were sprayed with 0·03 per cent. pyrethrins and 0·3 per cent. piperonyl butoxide. Average repellencies in the afternoon were 57·1 for AT 25 (40 per cent. butoxypolypropylene glycol, 2 per cent. piperonyl butoxide and 0·2 per cent. cyclethrin), 60·2 for 0·5 per cent. pyrethrins with 5·2 per cent. piperonyl butoxide, 60·3–73·6 for 2 per cent. R-326, and 65·6 and 82·3 for 2 and 5 per cent. Tabutrex both with 1 per cent. methoxy-DDT (methoxychlor). Only the last spray differed significantly from the others, and it is possible that it was more efficiently applied.

An attempt to compare formulations containing pyrethrins and piperonyl butoxide or Tabutrex and oleic acid by applying them topically to cows was complicated by the fact that the number of flies present on the cows treated with Tabutrex increased during periods of a few hours following the use of sprays containing Tabutrex or pyrethrins on other cattle in the same barn. It appeared that flies exposed to the spray mists temporarily lost their ability to discriminate between treated and untreated surfaces. Formulating sprays with quick-acting insecticides and maintaining a proper balance between the repellent and the killing agent should obviate desensitisation and provide a spray that will kill flies by contact and give good repellency for one or more days.

In a comparison of emulsion concentrates applied at 1 U.S. quart diluted spray per cow, the best was 10 per cent. Tabutrex with 30 per cent. oleic acid at a dilution of 1:4; its repellency figures and (in brackets) those of 20 per cent. Tabutrex at the same dilution alone were 100 (88·3), 97·3 (91·9), 95·6 (79·2) and 74 (40) on the first four days and 82·1 (46·4) on the sixth. When compared at a dilution of 1:9 the same concentrates were a little more and a little less effective, respectively, than one containing 1 per cent. pyrethrins and 10 per cent. piperonyl butoxide, but the 20 per cent. Tabutrex was ineffective at 1:9 if the rate of application was 1 U.S. pint or less. In further comparisons of various combinations of solvents, repellents, and insecticides in emulsion concentrates, the addition of oleic acid or butoxypolypropylene glycol significantly prolonged the effectiveness of Tabutrex formulations, but the addition of methoxy-DDT was only slightly beneficial. Flies attempting to attack animals recently treated with

Tabutrex were repelled as soon as or even before they alighted, but if the treatments had aged for 2–3 days, the flies walked among the hairs and were repelled only when they began to push the proboscis down to the skin.

Parker (D. D.). **Attempted Transmission of *Pasteurella tularensis* by three Species of Fleas.**—*J. econ. Ent.* **50** (1957) no. 6 pp. 724–726, 9 refs. Menasha, Wis., 1958.

The presence of *Bacterium* (*Pasteurella*) *tularense* in fleas taken from rabbits or rodents in nature has occasionally been recorded, but such records are very few in comparison with the numbers of specimens examined, and fleas have not been shown to be effective vectors of tularaemia [*cf. R.A.E.*, B **37** 17]. However, interest in the relationship to tularaemia of fleas common in the area of the Great Salt Lake Desert was stimulated by a report in 1954 of the taking of infected fleas from the antelope ground squirrel (*Citellus leucurus leucurus*) and by the annual occurrence, between 1937 and 1953, of 20–65 cases of tularaemia in man in Utah, and experiments were accordingly made with *Cediopsylla inaequalis inaequalis* (Baker) from rabbits (*Sylvilagus*), *Thrassis bacchi gladiolis* (Jordan) from *Citellus l. leucurus* and *Pulex irritans* L. from the desert kit fox (*Vulpes macrotis*). The rodents used as hosts, except in one negative experiment, were *C. l. leucurus* or guineapigs. It was shown that *Cediopsylla* and *Thrassis* would acquire the infection from moribund infected rodents (those in which bacteraemia was adequate) and would retain it for at least 24 hours, but no infection was detected in ten examples of *Pulex*. No transmission to healthy rodents was obtained in experiments in which 160 examples of *Cediopsylla*, 200 of *Thrassis* and 200 of *Pulex* were transferred to them in batches of 20–50 after having been confined with infected ones.

Anthony (D. W.). **Pyrethrum Emulsions for Surveys of Tabanid Larvae.**—*J. econ. Ent.* **50** (1957) no. 6 pp. 740–742, 3 refs. Menasha, Wis., 1958.

Treatment of soil with insecticides to help in the making of surveys and collections of Tabanid larvae [*cf. R.A.E.*, B **46** 136] was tested over two seasons in central Florida. Plots along the margins of fresh-water lakes and streams and in bogs and marshes were treated with emulsions of a commercial concentrate containing pyrethrins and piperonyl butoxide, two specially formulated pyrethrum concentrates, one with and one without piperonyl butoxide [**45** 181], or a commercial concentrate of γ BHC (lindane). All the emulsions were applied as surface treatments at the rate of 0·5 U.S. gal. per sq. yard and the specially formulated emulsions were also injected at the same rate 3–4 ins. below the soil surface. Surface applications of the pyrethrum emulsions forced many larvae to the surface when soil conditions were suitable for the emulsions to penetrate, and most of the larvae survived and were successfully kept for biological studies. Compared at concentrations of 0·001–0·004 per cent. pyrethrins, the special formulation containing piperonyl butoxide was at least equal to and usually much better than the commercial preparation, probably because of the fine colloidal texture of the emulsion, which gave excellent penetration. Compared at 0·0005–0·002 per cent. pyrethrins, the special formulation with the synergist acted more quickly and brought up a higher proportion of the population than the one without. Emulsions containing 0·5 per cent. γ BHC were unsatisfactory; they killed many larvae in the soil and those that

reached the surface did so slowly and died within 72 hours. Injection treatments showed advantages in very wet situations and other areas in which surface applications did not penetrate effectively. Larvae of nine species were obtained by the surface applications and of six, including two additional ones, by the injections, but the proportion of a given population that came to the surface varied with the activity of the larvae and consequently with the species concerned.

BARKER (R. J.). **The Absorption and Degradation of DDT at varied Dosages by the House Fly.**—*J. econ. Ent.* **50** (1957) no. 6 pp. 748–750, 1 graph, 17 refs. Menasha, Wis., 1958.

Different amounts of DDT were administered topically in a constant volume of acetone to house-flies (*Musca domestica* L.) of five strains, and the absorption and degradation of the DDT in survivors [*cf. R.A.E.*, B **46** 139] were determined 24 hours later. The results are shown in a table and a graph. Increased dosages gave increased absorption, but the increases in absorption were proportionally less at larger dosages. Generally, if dosages above 1 μg. per fly were changed, absorption was changed about half as much. The amount of DDT that can be in contact with a given area of cuticle is limited, so that additional DDT in the same amount of solvent increases the depth of the deposit, but not the amount immediately available for absorption. Although the different strains varied in susceptibility to DDT, the survivors showed no significant differences in the amounts absorbed. The percentages of the absorbed DDT degraded by the flies varied from 84 to 99 per cent. but showed no trend dependent on dosage.

FONTAINE (R. E.), GREEN (D. H.) & SMITH (L. M.). **Ecological Observations of the Valley Black Gnat, *Leptoconops torrens* Townsend.**—*J. econ. Ent.* **50** (1957) no. 6 pp. 764–767, 3 refs. Menasha, Wis., 1958.

Leptoconops torrens (Tns.) causes considerable annoyance to man and domestic animals by biting in spring and early summer in many parts of California [*cf. R.A.E.*, B **22** 173]. Clothing offers little protection from attack, and allergic manifestations and secondary infections often necessitate medical attention. Outside California, this Ceratopogonid has been recorded from Texas, Nevada, New Mexico and Colorado. Only adults were known until 1944, when larvae were discovered at depths of 15–30 inches in clay adobe soil in a habitat investigated by L. M. Smith in central California. He found that the larval stage lasts at least two years, with summers spent in immobile aestivation and that the adults emerge from cracks that appear in the soil soon after the end of the rainy season, usually in May. He caught 213 adults in three emergence traps on this habitat in 1943, and all emerged between 21st May and 12th June. Engorged females return to the crack system to oviposit, and the larvae probably hatch with the advent of the autumn rains and burrow through the mud in the crack faces. The fully developed larvae apparently enter a prolonged diapause instead of pupating if environmental conditions prevent the cracking of the soil and so would prevent emergence of the adults from it.

A search for breeding places in the same area in 1955–56 resulted in the finding of larvae at the original site and also at four others at depths of 18–36 in. in fine-textured clay soils containing light to heavy concentrations of alkali. These breeding sites were in depressions in low-lying

terrain with poor drainage. Adults were first seen on 26th May in 1956 and were taken until 18th June in emergence traps used over the breeding areas and one potential breeding area from 28th May to 29th June. The finding of larvae in the original site and the emergence of adults from it were unexpected, as it had been covered with an 18-in. layer of top soil in October 1952. Since, however, the larvae were about as deep in the clay as they had been in 1944 and only six adults were caught in three emergence traps, as compared with 213 in 1943, it is thought more likely that the larvae had remained in diapause than that the site was still being infested. Attempts to induce larvae to pupate in the laboratory were unsuccessful, and no pupae have been found under natural conditions. The adults, which bite outdoors and rarely enter buildings, were most numerous and aggressive during the hottest parts of the day on still days. They were inactive at temperatures below 70°F., at night, and during periods of high wind and were not caught in light-traps.

Gahan (J. B.), Wilson (H. G.), Keller (J. C.) & Smith (C. N.). **Organic Phosphorus Insecticides as residual Sprays for the Control of House Flies.**—*J. econ. Ent.* **50** (1957) no. 6 pp. 789–793, 12 refs. Menasha, Wis., 1958.

Of 30 organic phosphorus compounds tested in the laboratory against adult house-flies (*Musca domestica* L.) of a normally susceptible strain by application to plywood panels at 100 mg. per sq. ft., eight were sufficiently toxic to give 100 per cent. mortality for at least 14 days with exposure for two hours. The most promising were Dow ET-15 [O-methyl O-2,4,5-trichlorophenyl phosphoramidothioate], Dow ET-57 [O,O-dimethyl O-2,4,5-trichlorophenyl phosphorothioate], diazinon [O,O-diethyl O-2-isopropyl-4-methyl-6-pyrimidinyl phosphorothioate], Bayer 21/199 [O,O-diethyl O-3-chloro-4-methyl-7-coumarinyl phosphorothioate] and EPN [O-ethyl O-p-nitrophenyl phenylphosphonothioate].

Diazinon, Dow ET-57, Dipterex [dimethyl 2,2,2-trichloro-1-hydroxyethyl-phosphonate], Chlorthion [O,O-dimethyl O-3-chloro-4-nitrophenyl phosphorothioate], Am. Cyanamid 4124 [O,O-dimethyl O-2-chloro-4-nitrophenyl phosphorothioate], Bayer 21/199 and malathion, which had all shown some toxicity and were commercially available, were applied to animal barns in Florida in which the strains of flies present were known to be resistant to all the chlorinated insecticides, and diazinon and malathion were compared with DDT on farms in Nebraska where there had been no extensive spraying of buildings and the resistance of the flies to insecticides was not known. Dipterex was used in a water solution, malathion, Chlorthion and DDT in emulsions and the other compounds in emulsions and wettable-powder suspensions.

In Florida, diazinon at 50–200 mg. per sq. ft. gave 90–100 per cent. control for periods ranging from three days to at least seven weeks. It was more effective when applied to both walls and ceilings than when applied to ceilings only, even if the total amount applied per barn was the same. Dow ET-57 was highly effective for 1–28 days, and was about as durable at 50 mg. per sq. ft. as at 100 or 200 mg. Am. Cyanamid 4124 was satisfactory for 1–14 days. Malathion, Dipterex, Baver 21/199 and Chlorthion usually gave 90 per cent. control for no more than one week. Treating the floor as well as the walls and ceiling did not improve the results obtained with Bayer 21/199. Sugar was added to some formulations, but did not greatly extend their durability and caused unsightly mould in many of the barns. In Nebraska, diazinon gave over 90 per cent. control for 9–35 days

at 50–100 mg. per sq. ft., and malathion for one week or less at 100 and 200 mg. DDT at 200 mg. was less effective than either.

Roberts (I. H.), Mansfield (M. E.) & Cmarik (G. F.). **Ineffectiveness against Cattle Grubs of Phenothiazine and Stilbesterol in daily Diet of fattening Steers.**—*J. econ. Ent.* **50** (1957) no. 6 pp. 808–809, 16 refs. Menasha, Wis., 1958.

The following is based on the authors' summary. Phenothiazine in daily doses of 2 g., stilboestrol in daily doses of 10 mg. and a combination of both were administered in the diet to young steers in Illinois during a fattening period of 120 days from 20th October 1955. Encystment of larvae of *Hypoderma lineatum* (Vill.) in the backs of the treated and control animals began in mid-December and was completed by 14th February. Extraction of all larvae from their cysts showed that the treatments had no influence on the arrival of larvae in the subcutis or their subsequent survival in the cysts.

Mulla (M. S.) & Barnes (M. M.). **On Laboratory Colonization of the Eye Gnat, *Hippelates collusor* Townsend.**—*J. econ. Ent.* **50** (1957) no. 6 pp. 813–816, 1 fig., 5 refs. Menasha, Wis., 1958.

Current studies on the biology and control of *Hippelates collusor* (Tns.), which is much the most abundant species of its genus in the Coachella Valley of California [*cf. R.A.E.*, B **41** 87], were begun in 1956, and a practicable technique for mass laboratory rearing was worked out, by means of which it has been maintained in the laboratory for eight generations. The larval medium consists of a mixture of fine Vermiculite, lucerne meal and brewer's yeast, which is wetted with water, put in to fill the lower half of a specially constructed wooden cage, 18 ins. long, 12 ins. wide and 11 ins. deep, and kept uniformly damp by a simple watering device; the upper half of the cage, which contains the adults, is a hinged lid 5 ins. high, with a screen back and front to provide light and ventilation. It is not uncommon to obtain an emergence of 5,000–6,000 adults in a cage stocked with 300–400. To ensure that the emerging adults are free of litter-breeding mites (*Anoctus*), it has been found necessary to spray the top 1–2 ins. of medium just after emergence has begun with 50 ml. of an emulsion containing 1 per cent. DMC (Dimite [di(p-chlorophenyl)methylcarbinol]).

As the preoviposition period appears to last about a week at 85°F. and 20–25 per cent. relative humidity, it is necessary to keep the adults alive longer for satisfactory colonisation. They suffered high mortality when given foods in solution, but lived for about a fortnight on a complete diet provided in dry form by soaking absorbent dental rolls in a solution containing 20 ingredients, including honey and human blood, and then drying them. The prepared rolls could be stored for months in a refrigerator.

Ware (G. W.) & Roan (C. C.). **The Interaction of Piperonyl Butoxide with Malathion and five Analogs applied topically to Male House Flies.**—*J. econ. Ent.* **50** (1957) no. 6 pp. 825–827, 11 refs. Menasha, Wis., 1958.

Comparisons are made of the LD50's for male house-flies (*Musca domestica* L.) of malathion [O,O-dimethyl S-1,2 di(ethoxycarbonyl)ethyl phosphorodithioate] and five analogues applied to them topically in acetone, alone and

with piperonyl butoxide (1:10 by weight). The analogues (which are designated by numbers and graphic formulae) were, in descending order of toxicity both with and without piperonyl butoxide, 4018 [O,O-diethyl S-1,2-di-(methoxycarbonyl)ethyl phosphorodithioate], 3975 [O,O-diethyl S-1,2-di-(ethoxycarbonyl)ethyl phosphorodithioate], 4389 [O,O-dimethyl S-1,2-di(ethoxycarbonyl)ethyl phosphorothioate (malaoxon)], 4075 [O,O-dimethyl S-1,2-di(methoxycarbonyl)ethyl phosphorodithioate] and 4128 [O,O-dimethyl S-1,2-di(propoxycarbonyl)ethyl phosphorodithioate]. Malathion itself was fourth in order of toxicity when the compounds were used alone and fifth when they were used with piperonyl butoxide. Piperonyl butoxide showed synergism with the two O,O-diethyl compounds and malaoxon and antagonism with the other three, the ratio of the LD50 with it to that without it being 0·54 for malaoxon, 0·71 and 0·77 for 3975 and 4018, 1·11 for 4075, 1·6 for malathion [*cf R.A.E.*, B **45** 111–112], and 2 for 4128. The figures for the last three suggest that the antagonism increases with an increase in the length of the alkoxy group from methyl to propyl. Single differences in structure associated with antagonism or synergism can be seen by comparing 4075 with 4018, and malathion with 3975 or with malaoxon. It is possible that these organo-phosphates may have varying degrees of solubility in piperonyl butoxide, which could account in some degree for their differences in activity with it.

Bruce (W. N.). **Evaluation of synergized Pyrethrins on various Strains of House Flies.**—*J. econ. Ent.* **50** (1957) no. 6 pp. 828–829. Menasha, Wis., 1958.

Female house-flies (*Musca domestica* L.) of several strains resistant to various insecticides or normally susceptible were treated topically with acetone solutions of pyrethrins with synergists in various ratios to determine the relative effectiveness of the latter. The synergists were piperonyl butoxide, MGK-264 [N-(2-ethylhexyl)bicyclo(2.2.1)-5-heptene-2,3-dicarboximide], Sesoxane [2-(2-ethoxyethoxy)ethyl 3,4-methylenedioxyphenyl acetal of acetaldehyde] and a 3:5 mixture of the first two. The flies were kept at 80° F. for 24 hours before mortality counts were made, and LD50 values were calculated from the results. These, which are given in a table, show a substantial difference in susceptibility among the strains. Sesoxane was the most effective synergist and MGK-264 much the least effective, but the mixture of MGK-264 and piperonyl butoxide was equal or superior to piperonyl butoxide alone and would be much more economical to use. Its effectiveness may well be due to a combination of two different modes of synergistic action.

Raun (E. S.) & Herrick (J. B.). **Clinical Test of the Efficacy of Dow ET-57 for Grub Control in Cattle.**—*J. econ. Ent.* **50** (1957) no. 6 p. 832. Menasha, Wis., 1958.

Dow ET-57 (purified O,O-dimethyl O-2,4,5-trichlorophenyl phosphorothioate) was administered by capsule at 110 mg. per kg. on 28th December 1956, 110 days before slaughter, to 77 yearling steers in Iowa, moderately infested with cattle grubs (*Hypoderma*). At counts by palpation 49 and 83 days after treatment, no larvae were found on the treated animals, but the same number of controls had an average of 2·2 per animal. At slaughter, the 77 treated and 77 control animals had, respectively, totals of 44 and 194 larvae in the carcasses and 5 and 370 in the hides. The average gains of the

treated and control animals were 264 and 245 lb. per head, respectively, and the amounts of feed used per 100 lb. gain were 979 and 1,033 lb. There was no appreciable difference in the grades of cattle in the two groups.

BALLARD (R. C.). **An Analysis of *Stomoxys calcitrans* (L.) for Vitamin A.**—*J. econ. Ent.* **50** (1957) no. 6 pp. 836–837, 4 refs. Menasha, Wis., 1958.

As vitamin A appears to be absent in most insects, although it exists in many arthropods and is believed to be a factor in the visual system of some, tests were made for its presence in two adult populations of *Stomoxys calcitrans* (L.), comprising 2,500 flies fed on dextrose only and 3,500 fed on beef blood and then starved for 24 hours. The results were negative in both groups, but the technique did not exclude the possibility that the vitamin was present only in the eyes.

FOX (I.). ***Ornithonyssus bursa* (Berlese) attacking Man in Puerto Rico.**—*J. econ. Ent.* **50** (1957) no. 6 p. 838, 3 refs. Menasha, Wis., 1958.

An outbreak of *Ornithonyssus bursa* (Berl.) occurred at an Air Force Base in Porto Rico in late June 1957. The mites were abundant on benches, walls and the wings of aircraft, caused considerable annoyance to workers by crawling over the skin and clothing, and bit one of them. The infestation was traced to Porto Rican grackles (*Holoquiscalus niger brachypterus*), which were abundant and nesting at the Base, when hundreds of mites in various stages of development were found on a moribund nestling in July. *O. bursa* is not known to have been recorded before from Porto Rico. The virus of western equine encephalitis is reported to have been isolated from it in nature [*cf. R.A.E.*, B **38** 37; **44** 162].

NELSON (W. A.), SLEN (S. B.) & BANKY (E. C.). **Evaluation of Methods of estimating Populations of the Sheep Ked, *Melophagus ovinus* (L.) (Diptera: Hippoboscidae), on mature Ewes and young Lambs.**—*Canad. J. Anim. Sci.* **37** no. 1 pp. 8–13, 1 graph, 11 refs. Ottawa, 1957.

Six methods of estimating populations of the sheep ked (*Melophagus ovinus* (L.)) were evaluated on mature ewes and young lambs of four breeds in Alberta in 1953. The actual populations were determined by picking off and counting all the keds on 6–8 ewes and 7–11 lambs of each breed. The "total live-count" [*R.A.E.*, B **39** 200] gave the highest degree of accuracy, the coefficients of variation of the ratios of the sample counts to the actual populations being least by this method (20·1 for ewes and 16·6 for lambs), as the ratios were unaffected by variations in the degree of infestation, body size or fleece characteristics. It was the only satisfactory method studied and was shown to provide a valid estimate if all the keds on only one side of the sheep were counted. In vertical parting methods [**43** 131], the ratios decreased as the distance between the partings increased from 2 to 3 to 4 in., and counts were affected by marked differences in body size and fleece characteristics. The 12-inch parting method [**41** 73] accounted for only a small portion of the ked population and, mainly for this reason, its accuracy was low. In the five-minute count [**43** 131], the ratio depended on the

degree of infestation, body size and, to a smaller degree, the fleece characteristics. It was concluded from this that a time-constant method was inadequate. The methods giving the highest ratios had the lowest coefficients of variation.

Teskey (H. J.). **Observations on the seasonal Development of hypodermal Larvae of the Northern Cattle Grub, *Hypoderma bovis* (L.) (Diptera: Oestridae) at Guelph, Ontario, and their Implications in Control Programs.**—*Canad. J. Anim. Sci.* **37** no. 1 pp. 114–120, 1 graph, 15 refs. Ottawa, 1957.

The following is mainly based on the author's introduction and summary. A campaign that had been inaugurated in 1947 for the control of *Hypoderma bovis* (Deg.) in a few townships in Ontario included 249 townships in which more than a million cattle were treated by 1955. It was reported in the latter year that the number of larvae per animal in townships treated since 1948 had fallen from 12·3 to 1·6. As, however, it appeared that eradication would not be achieved unless the effectiveness of control was increased, observations on the seasonal distribution and development of the hypodermal larvae were made in 1954 and 1955 at Guelph, 20 heifers being used in each year.

In 1954 and (in brackets) 1955, 16 (17) of the heifers were infested with a total of 230 (275) larvae. The first larva was found in the back of a heifer on 3rd February (22nd January) and the last appeared on 15th June (14th May). The first larva dropped from the back on 5th May (9th May) and the last on 25th August (25th July). The heifers were infested for 203 days in 1954 and 184 days in 1955. The average period of hypodermal development was 82 days. Mortality of the larvae in the back averaged 44 and 54 per cent. in the two years; all the larvae died in two animals that exhibited distinct resistance. Seasonal development was similar in the two years. Larvae appearing in the back early needed 30 and 40 days longer to complete their development than those appearing late. In the light of the observations, it is suggested that two or possibly three treatments with rotenone should be made: one about 1st May, just before the first larvae fall and when most are in the third instar, the second 40–45 days later and the third 30 days after the second. These dates are considerably later than those of the schedule at present in use in Ontario.

Papers noticed by Title only.

Pierquin (L.) & Niemegeers (K.). **Tables dichotomiques pour l'identification des tiques adultes du Congo belge et Ruanda-Urundi.**—*Bull. agric. Congo belge* **49** no. 2 pp. 421–460, 1 fldg. pl., 31 refs. Brussels, 1958. (With a Summary in Flemish.)

Forgash (A. J.). **The inhibitory Effect of Arsenic Trioxide on the reduced Glutathione (GSH) of several Tissues of *Periplaneta americana* (L.).**—*J. econ. Ent.* **50** (1957) no. 6 pp. 750–752, 7 refs. Menasha, Wis., 1958. [See *R.A.E.*, A **47** 16.]

EDITORIAL.

Retirement of Capt. H. S. Bushell, O.B.E., M.A.

Capt. H. S. Bushell retired on the 19th January 1959, after 39 years on the staff of the Commonwealth Institute of Entomology, for almost the whole of which he was Assistant Editor of the *Review of Applied Entomology* and responsible, under the Director, for its production. The nature of the *Review* was defined, and its policy initiated, by Sir Guy Marshall and Dr. S. A. Neave, and these have remained essentially unchanged to the present time, but it would be difficult to exaggerate the importance of the part played by Capt. Bushell in developing the *Review* so as to meet the demands made on it, particularly in recent years, by the progressively increasing range and complexity of its subject matter. The standards that he set himself and those associated with him have become a part of the tradition of the *Review*; his unique experience has also been available in a wider field through his membership of the Abstracting Services Consultative Committee from the time that this was set up, in 1948, by the Royal Society. The efforts of those concerned with scientific abstracting can rarely receive individual recognition, and it is fitting at this time to acknowledge in this *Review* the debt that it owes to Capt. Bushell's ability and to his long and devoted service.

Stone (A.). **Corrections in the Taxonomy and Nomenclature of Mosquitoes (Diptera, Culicidae).**—*Proc. ent. Soc. Wash.* **58** (1956) no. 6 pp. 333–344, 5 figs., 8 refs. Washington, D.C., 1957.

Changes in the scope and subfamilies of the Culicidae and in the nomenclature of some 20 of the species and one subgenus are made in order that they can be incorporated in a forthcoming catalogue of the family. The three former subfamilies, Dixinae, Chaoborinae and Culicinae, are all accorded family rank, and the Culicidae as thus restricted are divided into the subfamilies Anophelinae, Culicinae and Toxorhynchitinae. The Culicinae will in turn be separated into several tribes, which will include the Culicini, Aëdini, Culisetini, Uranotaenini and Sabethini.

The individual species discussed include *Mansonia bonneae* Edw. and the one currently known as *M. longipalpis* (Wulp). Edwards proposed the name *bonneae* for a taxon that Bonne-Wepster [*R.A.E.*, B **19** 5] described as *Taeniorhynchus annulipes* var. A, but differences between the genitalia of the holotype male of *bonneae*, which are shown in figures, and those figured by Bonne-Wepster make this identification doubtful. *M. longipalpis*, described in 1881, is a synonym of *M.* (*Culex*) *dives* (Schiner), since the latter name was proposed in 1868 to replace the preoccupied *Culex annulipes* Wlk., with which *M. longipalpis* is identical [**13** 48].

Levi-Castillo (R.). **A systematic Note on *Haemagogus spegazzinii* Brèthes, 1912 (Diptera, Culicidae).**—*Proc. ent. Soc. Wash.* **58** (1956) no. 6 pp. 345–347, 12 refs. Washington, D.C., 1957.

Galindo (P.). **On the Validity of *Haemagogus spegazzinii falco* Kumm et al., 1946 (Diptera, Culicidae).**—*Op. cit.* **59** no. 3 pp. 121–124, 5 figs., 4 refs. 1957.

The authors of both these papers have examined the terminalia of the holotype male of *Haemagogus janthinomys* Dyar from Trinidad, but

draw different conclusions as to its identity. Levi-Castillo considers it to be a male of *H. spegazzinii falco* Kumm, Osorno-Mesa & Boshell-Manrique, which should therefore be known as *H. s. janthinomys*, whereas Galindo considers that it and other specimens from Trinidad represent intergradations between *falco* and typical *H. spegazzinii* Brèthes [*cf. R.A.E.*, B **39** 190] but are more closely allied to the latter, so that *janthinomys* should be considered a synonym of *H. s. spegazzinii*.

Parker (A. H.). **The Effect of Acetone Concentration and larval Density on the Mortality of *Aëdes aegypti* Larvae exposed to DDT and Dieldrin.**—*Ann. trop. Med. Parasit.* **51** no. 4 pp. 368–373, 4 refs. Liverpool, 1957.

The following is almost entirely based on the author's summary. Experiments were carried out to determine the effect on the mortality of larvae of *Aëdes aegypti* (L.) exposed to DDT or dieldrin dispersed in water as acetone solutions of variations in the concentration of acetone and the number of larvae in the medium. A tenfold variation in the concentration of acetone (from 0·01 to 0·1 per cent.) had no significant effect on the mortality of larvae of any age-group when they were exposed to their LC50 of DDT or dieldrin [*R.A.E.*, B **46** 194] either for one hour (in the case of first- to third-day larvae) or for 24 hours (in the case of fourth- to eighth-day larvae). Larvae exposed for one hour were kept for 24 hours before mortality was assessed. A 100-fold variation in acetone concentration (from 0·001 to 0·1 per cent.) likewise had no significant effect on the mortality of fourth-day larvae exposed to the same insecticides for 24 hours.

Reduction in the density of eighth-day larvae from 20 to ten, or from ten to five, per 100 ml. resulted in a marked rise in kill effected by DDT and dieldrin when exposures were for 24 hours, but caused no significant change when exposures were for one hour. When, however, the density of eighth-day larvae exposed to DDT for one hour was increased from 20 per 100 ml. to 20 per 20 ml., mortality was reduced. When fourth-day larvae were exposed for 24 hours, reducing density from 20 to ten and ten to five larvae per 100 ml. increased the mortality when the insecticide used was DDT, but did not affect it when the insecticide was dieldrin.

In a discussion of these results, it is suggested that at least part of the apparent decrease in susceptibility with age previously recorded for larvae of *A. aegypti* [*loc. cit.*] may have been due merely to the increase in the size of the larvae, and that, in standardised susceptibility tests, the number of larvae exposed to a given amount of insecticidal solution should be specified.

Hale (J. H.), Lim (K. A.) & Colless (D. H.). **Investigation of domestic Pigs as a potential Reservoir of Japanese B Encephalitis Virus on Singapore Island.**—*Ann. trop. Med. Parasit.* **51** no. 4 pp. 374–379, 3 refs. Liverpool, 1957.

As the main animal food of the Chinese population of Singapore Island is pork, there is a large population of pigs with a considerable turnover. It was therefore considered worth while examining their ability to act as reservoirs of Japanese B encephalitis. Of 140 serum samples collected from pigs born and bred on the Island, 130 had neutralising antibodies to Japanese B virus, and evidence was obtained that these had been acquired as a result of infection. A litter of pigs, born and maintained in a mosquito-proof sty, all

possessed neutralising antibodies presumably acquired from the sow; these they did not lose until they were eight months old. A sow of this litter produced, at six months, five young which were all found to be antibody-free. Two of these when two months old, and two of the pigs from the first litter which were by then also free of antibodies, were given subcutaneous injections of 500 and 5,000 mouse intracerebral LD50's of the virus. Inoculation of their serum into mice showed that the two older pigs developed no viraemia, but the two younger ones did, after 49–96 and 72 hours, respectively, though neither showed any observable signs of illness. All four animals had neutralising antibodies 14 days after inoculation.

When infected females of *Culex tritaeniorhynchus* Giles, which is known to be a vector of Japanese B encephalitis [*cf. R.A.E.*, B **46** 178], fed on a third pig of the second litter, the animal developed low-grade viraemia. A female of *C. tritaeniorhynchus* became infected after taking a blood-meal from another pig of this litter when it was five months old, 48 hours after it had been inoculated subcutaneously with 1,000 mouse intracerebral LD50's, although the viraemia developed by the pig was weaker and of shorter duration than that developed by those two months old.

As 7 per cent. of the pig population is free of antibodies, a proportion of the young will therefore always be born susceptible to infection. In view of this and the experimental results and the fact that *C. tritaeniorhynchus* commonly feeds on pigs, it is concluded that these animals may act as a reservoir of Japanese B virus in Singapore.

MATTINGLY (P. F.). **Genetical Aspects of the *Aëdes aegypti* Problem. I. Taxonomy and Bionomics.**—*Ann. trop. Med. Parasit.* **51** no. 4 pp. 392–408, 105 refs. Liverpool, 1957.

The following is substantially the author's summary. The yellow-fever mosquito currently known as *Aëdes aegypti* (L.) is highly variable in appearance, but three forms are readily distinguishable on colour characters, at least in the female, and show associated behaviour characters of considerable importance. It is not at present possible to provide definitive names for these forms, since it has been found and is here shown that the Linnaean description of *Culex aegypti* from Egypt applies to the common Palaearctic species of *Ochlerotatus*, known as *A. caspius* (Pall.) and not to the yellow-fever mosquito, but it has been decided to ask the International Commission on Zoological Nomenclature to fix the name *aegypti* in its present attachment to the latter. In the meantime, the three forms are given provisional names. They are the type form of *aegypti* (a brown or blackish form widely distributed throughout the range of the species but absent from inland areas of Africa south of the Sahara), var. *queenslandensis* (Theo.) (a pale form described from northern Australia and having much the same distribution as the type form), and subsp. *formosus* (Wlk.) (a black form described from Sierra Leone and confined to Africa south of the Sahara, where it is the only form that occurs except in coastal areas and a few areas of limited inland penetration). It is noted that in general the distribution of *A. aegypti* outside Africa is sporadic and often mainly coastal, and this is taken as good evidence that the type form and var. *queenslandensis* are of comparatively recent introduction from coastal regions of Africa. It is not, however, considered that the species necessarily originated in tropical Africa, since there is reason to believe that it may have had a wide distribution in the southern Palaearctic in pre-glacial times and may have originated there.

Var. *queenslandensis* appears to be entirely domestic, feeding and

ovipositing in or around human habitations in all parts of its range. The type form is also mainly domestic in Africa, but it appears to possess some capacity for limited breeding and feeding in natural habitats, and this capacity is apparently enlarged in some other parts of the range, where it may be semi-wild. Subsp. *formosus*, on the other hand, can exist as a fully wild mosquito, although it may become largely domesticated, under either rural or urban conditions.

WHARTON (R. H.). **Studies on Filariasis in Malaya: the Efficiency of *Mansonia longipalpis* as an experimental Vector of *Wuchereria malayi*.** —*Ann. trop. Med. Parasit.* **51** no. 4 pp. 422–439, 4 graphs, 21 refs. Liverpool, 1957.

The following is almost entirely based on the author's summary. An account is given of studies on the relation between the density of microfilariae of *Wuchereria malayi* and infection in mosquitos referred to as *Mansonia longipalpis*, the chief vector in East Pahang. It is pointed out in a foot-note that the name *M. longipalpis* (Wulp) should be replaced by *M. dives* (Schiner) [*cf. R.A.E.*, B **47** 17], but it is retained and used to include both this species and *M. bonneae* Edw., which occurs with it in the area and is an equally suitable host for *W. malayi* [**47** 5], as their taxonomic position is in doubt and is being investigated. It was found that the number of filarial larvae (of all stages) in females dissected 10·5–11 days after they had fed on a carrier of *W. malayi* was directly proportional to the number of microfilariae (mf.) in the peripheral blood at the time of the feed, and that the mean number of larvae per mosquito was about five times the number of mf. per cu. mm. of the blood for at least 15·5 days after feeding. The percentage of mosquitos that became infected was also found to be related to the mf. density. Whereas 12 per cent. became infected after feeding on a carrier with only 0·025 mf. per cu. mm., all became infected after feeding on carriers with 2 mf. per cu. mm. or more. It follows that there can be no non-infective mf. level in the blood other than zero [*cf.* **44** 63], but that few mosquitos will become infected when the level is low. When females were fed on carriers with mf. densities ranging from 0·025 to 11·7 per cu. mm., the proportion of larvae that were in stage III (mature) 10·5–11 days later was fairly constant (mean, 65 per cent.; range, 44–100 per cent.). With very high densities, however, larval development was retarded, and only 12 and 10 per cent. of the larvae had reached maturity by the 11th day in mosquitos that had fed on carriers with 25 and 22·5 mf. per cu. mm., respectively.

There was no difference between the survival rates of mosquitos fed on carriers with 2·3 mf. per cu. mm. or less and those of mosquitos fed on uninfected persons. Mosquitos that fed on carriers with 10·7 mf. per cu. mm. or more survived normally during the first week or so but died rapidly from about the eighth day onwards, when the filarial larvae were reaching maturity. In mosquitos that fed on carriers with intermediate mf. densities (5 and 6 per cu. mm.), the effect on survival was not well defined, but there appeared to be a selective mortality among mosquitos with the heavier infections.

The index of experimental infection (number of mature larvae per mosquito [**47** 5]) was calculated for mosquitos that had fed on carriers 10·5–11 days previously. The index rose as the mf. density in the donor increased from 0·025 to about 3 per cu. mm., reached a peak in the 3–11 range, and fell away when the density was higher, owing to the overcrowding and lethal effects of very large numbers of larvae. The index was

little changed by a delay in dissection for several days, except in the case of mosquitos that had fed on carriers with over 10 mf. per cu. mm. The range of susceptibility of individual females was found to be quite wide; no evidence of larval chitinisation was seen, nor were any mosquitos found to be completely inhospitable to infection, but development of the larvae was much slower in some mosquitos than in others. The 11 microfilaria-carriers used in the experiments ranged in age from 14 to 33 years and included one woman. There was no evidence of difference in the viability of microfilariae from different carriers or from the same carrier at different times. Some carriers had previously taken diethylcarbamazine [Hetrazan], and one had received his dose only five hours before mosquitos were fed, but the surviving microfilariae developed normally [*cf.* **44** 63].

The findings with *M. longipalpis* and *W. malayi* are compared with those recorded for other mosquito hosts of filarial infections.

Hafez (M.) & Attia (M. A.). **Rearing and culturing *Musca sorbens* Wied. in the Laboratory.**—*Bull. ent. Res.* **49** pt. 4 pp. 633–635, 7 refs. London, 1958.

In attempts to find media that could be used instead of human faeces for breeding *Musca sorbens* Wied., it was found that the females would oviposit on pads of cotton-wool soaked at least one day earlier in a 2:1 mixture of milk and water. They seldom laid many eggs on the pads, however, and a small quantity of faeces had to be used to obtain enough eggs for maintaining large colonies of the fly. The larvae were successfully reared by transferring the eggs to a small jar containing a mixture of 120 g. coarse wheat bran and 240 g. of the milk and water mixture. The jar was covered with muslin and kept at 27–28°C. [80·6–82·4°F.], and the larvae were fully grown in about three days. A layer of dry sand or bran was then put on top of the medium for them to pupate in, and the pupae were recovered by flotation when the culture was 5–6 days old. Up to 260 larvae could be reared in 30 g. mixture. Too low a density of larvae led to mould formation and fermentation. The average weights of pupae obtained in this medium and in human excrement were 11·8 and 14·2 mg., respectively. Rearing the larvae on a medium very similar to that of Richardson [*R.A.E.*, B **20** 261] gave a lower yield of pupae, which weighed only 6·6 mg. and produced undersized adults, and hardly any larvae completed their development on milk-soaked pads like those on which the flies oviposited, though similar ones had proved satisfactory for larvae of *M. domestica* L. [**37** 57].

Abedi (Z. H.). **Inheritance of Aldrin Resistance in the Indian House-fly, *Musca domestica nebulo* F.**—*Bull. ent. Res.* **49** pt. 4 pp. 637–642, 7 refs. London, 1958.

The following is virtually the author's summary. The inheritance of resistance to aldrin in *Musca domestica nebulo* F. was studied by making reciprocal crosses between individuals as well as groups of flies of an aldrin-resistant and a non-resistant strain at 28 ± 1°C. [82·4 ± 1·8°F.]. The offspring of all the families thus formed were tested by the topical application of constant-volume drops of various concentrations of aldrin solution in oil to the dorsum of the thorax of groups of flies. Mortality counts were made 24 hours after treatment. The results obtained indicated a multifactorial heredity for aldrin resistance in *M. d. nebulo* [*cf. R.A.E.*, B **45** 51]. The phenomenon was found not to be sex linked.

van Someren (E. C. C.), Heisch (R. B.) & Furlong (M.). **Observations on the Behaviour of some Mosquitos of the Kenya Coast.**—*Bull. ent. Res.* **49** pt. 4 pp. 643–660, 5 figs., 9 refs. London, 1958.

The mosquitos of two villages on the Kenya coast (Ganda and Mambrui) were studied from October 1949 to March 1952, during which time there were periods of very light, average and very heavy rainfall. Ganda had been used as a control when Mambrui was sprayed with DDT in 1949. The complete record of the species taken was published as part of a list already noticed [*R.A.E.*, B **44** 1]. The exact status of the species referred to as *Aëdes fryeri* (Theo.) has not yet been decided. The significance of colour variations in *A. aegypti* (L.) was not appreciated during the survey, and all forms were recorded under one heading. Recently, separation of the species into a type form, subspecies *formosus* (Wlk.) and var. *queenslandensis* (Theo.), has been proposed [**47** 19]. The last two forms are known to occur on the Kenya coast.

Catches made in the bush by sweeps with nets comprised 65 species, of which the 32 common ones are listed. Only 19 were taken regularly, and there was a seasonal fluctuation in the numbers of these, catches being highest in the hot, humid months of November–December. Only *Mansonia* (*Taeniorhynchus*) *uniformis* (Theo.), *M.* (*T.*) *africana* (Theo.), *A. woodi* Edw., *Culex invidiosus* Theo. and *C. guiarti* Blanch. were abundant. Mosquitos resting in houses by day were collected monthly by space-spraying from October 1949 to December 1951. Only the results at Ganda are given, as catches at Mambrui were small because of the DDT. Ten species were found, but only four in any numbers. Of these, *C. pipiens fatigans* Wied. and *A. aegypti* occurred regularly, the former being abundant, *Anopheles gambiae* Giles was seasonal and *A. funestus* Giles appeared only after exceptionally heavy rain. These four species as well as *M. uniformis* and *M. africana* were also taken regularly in a window exit trap and were the only ones taken in a window entrance trap. The exit trap caught large numbers of mosquitos of 30 species and the entrance trap only occasional ones seeking shelter by day; it is thought that the mosquitos that entered at night did so through cracks in the walls. These species were most active during the hours of darkness, mainly in the four hours before dawn, except *Aëdes aegypti*, which had two waves of activity, in the four-hour periods before dawn and before sunset, respectively.

Mosquitos coming to bite man were collected, monthly if possible, in situations designated bush, house and compound, and 35 species were taken. Biting cycles are recorded for ten of the 13 taken in numbers sufficient for them to be determined. These were much the same in the different environments in *A. aegypti*, *Anopheles gambiae* and *C. p. fatigans*, but the time and size of the main peaks varied. In *Aëdes aegypti*, a morning peak of activity was similar in the three situations, but an evening peak was much larger [*cf.* **44** 6] in the bush than elsewhere and occurred there just before sunset instead of after it; the population was probably mainly subsp. *formosus* in the bush and var. *queenslandensis* elsewhere. The biting activity of *Anopheles squamosus* Theo., *M. uniformis*, *M. africana*, *Aëdes fryeri*, *A. metallicus* (Edw.), *A. albicosta* (Edw.) and *C. antennatus* (Becker) was almost confined to the bush. Their biting cycles there are given, and records of them in the other two habitats are noted. The remaining species were rare, but 274 individuals of *Anopheles funestus* were taken in a house on one occasion; biting occurred irregularly through the night, but increased towards dawn and reached a sharp peak in the two hours after it.

Resting mosquitos were more numerous in the second half of the year from August to December, a period of light rainfall and high temperatures.

Biting mosquitos were more commonly taken, especially in the bush, in the second quarter of the year, during the main rainy season. The biting activity of some species increased in the houses in the second half of the year, when there are high winds, and biting in the bush was minimal.

WHITEHEAD (G. B.). **Acaricide Resistance in the Blue Tick, *Boophilus decoloratus* (Koch). Part I.**—*Bull. ent. Res.* **49** pt. 4 pp. 661–673, 1 pl., 16 graphs, 13 refs. London, 1958.

Boophilus decoloratus (Koch) in coastal regions of South Africa showed resistance to arsenic in 1940 [*R.A.E.*, B **35** 35], to BHC 18 months later [*cf.* **40** 108], and to DDT in the East London area in 1954. The DDT-resistant ticks also showed resistance to arsenic and BHC, but this developed independently, suggesting that the mechanisms were unrelated. An account is given of laboratory tests carried out to determine quantitatively the effectiveness of a number of insecticides on both unfed larvae and fully engorged adult females of the tick, and if possible to relate different types of resistance. Resistant ticks were obtained from the Ferndale and Allandale farms in the East London district and ticks regarded as sensitive to all insecticides from the Frankenwald Experimental Farm near Johannesburg were used as a standard of comparison; though both BHC and toxaphene dips had been used on this farm, no signs of increased tolerance had been noticed. Larvae were used when 15–30 days old, and adults 3–5 days after removal from the host. The adults were treated by a method adapted from that of Whitnall & Bradford [**36** 21] in an immersion apparatus adapted from one described by McIntosh [A **37** 138]. They were put with the appropriate concentration of insecticide in tubes measuring 1 × 3 in., which were tightly stoppered and rotated in the immersion apparatus for two minutes. The ticks were then allowed to drain for 30 minutes on cotton-wool moistened with the same insecticide and put into lightly stoppered tubes. The results are expressed in histograms which include the percentage kill and percentage control exerted by varying concentrations of insecticides. The percentage control included reduction in numbers or viability of the eggs laid as well as direct kill. Larvae were treated in the same apparatus in smaller tubes immersed for one minute, washed in distilled water, drained on copper gauze disks over absorbent paper and kept with the disks in tightly sealed glazed-paper envelopes; 700–1,000 larvae were used for each concentration, and the results were expressed as dose-response curves from which the LC50 could be accurately calculated.

Adult ticks from Allandale and Ferndale were 3–4 times as tolerant of sodium arsenite as the sensitive ones from Frankenwald. Both larvae and adults from Ferndale and adults from Allandale, when compared with Frankenwald ticks, were highly resistant to γ BHC, which conferred some cross-resistance to toxaphene, chlordane, dieldrin and aldrin. Adults from Allandale, in addition to being resistant to sodium arsenite, BHC, toxaphene, chlordane, dieldrin and aldrin, were highly resistant to DDT. Tests with adult ticks indicated that DDT-resistance conferred a cross-resistance to Dilan (a mixture of 1,1-bis(p-chlorophenyl)-2-nitropropane and 1,1-bis(p-chlorophenyl)-2-nitrobutane). The organo-phosphorus compounds tested, malathion and diazinon [O,O-diethyl O-2-isopropyl-4-methyl-6-pyrimidinyl phosphorothioate], were equally effective against ticks from Frankenwald, Ferndale and Allandale, the lack of cross-resistance contrasting with that previously observed with parathion [*cf.* B **42** 22]. Tests on adult females from Sandown near Johannesburg confirmed the existence of BHC-resistant arsenic-sensitive ticks in the interior districts of South Africa. The rapid

development of resistance in the coastal area is attributed to the very frequent dipping necessitated by the short life-cycle and year-round breeding brought about by the equable climate.

Hocking (B.) & Lindsay (I. S.). **Reactions of Insects to the olfactory Stimuli from the Components of an insecticidal Spray.**—*Bull. ent. Res.* **49** pt. 4 pp. 675–683, 4 figs., 14 refs. London, 1958.

Two kinds of equipment for measuring the reactions of insects to the olfactory stimuli provided by some common components of insecticidal sprays are described. One was a modification of the olfactometer of Wieting & Hoskins [*R.A.E.*, B **27** 166] and was used for tests with females of *Culex tarsalis* Coq. The other, which is new and gives rapid and reproducible evaluations, consists of a T-tube carrying a current of scented air across the top and admitting insects up the stem. It is based on the assumption that insects will fly upwind when exposed to an air current that carries an attractive odour. Cone traps prevented them from returning to the centre. As the rates of airflow needed, at least for small insects, are low enough to allow the use of an aspirator bottle to draw the air through, the apparatus can be used in the field; in the laboratory, a compressed-air supply is more convenient. Tests were made in this apparatus with *Drosophila melanogaster* Mg., two strains of *Musca domestica* L., a Chloropid and various mosquitos.

The combined results showed that technical DDT, diesel fuel oil and Velsicol AR50, an auxiliary solvent containing methylated naphthalenes (the ingredients of the spray most commonly used in aerial applications of insecticide for mosquito control in Canada) were all strongly repellent or contained strongly repellent components for all the species with which they were tested. DDT and the complete spray were tested against *Drosophila* and *Culex*, Velsicol against all test insects and fuel oil against all except the Chloropid. Velsicol was always more repellent than the fuel oil, DDT or the complete spray, and the last was more repellent than DDT to *Drosophila* but less so to *Culex*. Related species gave similar results with the two kinds of equipment. A strain of *M. domestica* resistant to DDT was less sensitive to Velsicol and the fuel oil than a normal strain. In the field, repellency may be expected to result in reluctance to settle in a sprayed area and a tendency to move downwind. Spraying successive swathes upwind forces repelled insects to pass through an already sprayed area.

Crosskey (R. W.). **First Results in the Control of *Simulium damnosum* Theobald (Diptera, Simuliidae) in Northern Nigeria.**—*Bull. ent. Res.* **49** pt. 4 pp. 715–735, 1 fig., 2 maps, 32 refs. London, 1958.

In 1954, an area in the north of the Abuja Emirate, in the Niger Province of Nigeria, was chosen for an experiment in the control of *Simulium damnosum* Theo.; this was an area not isolated from other foci of infestation, extending over some 1,200 sq. miles and having a population of 32,000 people. Technical DDT in diesel oil was selected as a larvicide, and the methods used for applying it to the rivers, which had rocky beds with rapids and falls, and assessing the effects of treatment are discussed. Breeding was found to be confined to the rocky parts of the main rivers. Applications were made at prearranged treatment points, weekly, for 12 weeks in the late dry seasons of 1956 and 1957. The post-treatment density of adults was assessed over a period of seven months and is compared with that existing in the year before treatment.

In the first year, the mean rate of application was 1·4 parts per million p.p′DDT applied over 30 minutes at each of four treatment points, and it resulted in the clearance of all breeding for a distance of 15–23 miles below these points and a reduction of adult fly density in the area of 96 per cent. However, immature stages reappeared in the cleared breeding grounds within six months, in spite of a mean wet-season fly density of only 0·35 fly per boy-hour. In the second year, when 1 p.p.m. p.p′DDT was applied over a period of 30 minutes, results were less successful, although three additional treatment points downstream of the original ones were used in order to effect control over greater distances. Adult density was reduced by only an estimated 83 per cent. The lower degree of control is attributed to the partial failure of the insecticide to reach the breeding sites because of the exceptionally low state of the rivers.

The larvae and pupae of the other species of *Simulium* present, including *S. bovis* De Meillon [*cf. R.A.E.*, B **46** 128], were eliminated for about the same distance as those of *S. damnosum*. Re-establishment of *S. bovis* seemed to be comparatively slow. Except for slight mortality among young fish, attributed to accidental impediments to the free flow of the larvicide, no toxic effects on other organisms were observed. The experiment showed that control by the application of larvicides in non-isolated foci is practicable, but that annual treatment might be necessary because of rapid re-establishment in cleared areas. The cost of this would be beyond the means of a small local administration. The effect of this degree of control on the incidence of human onchocercosis (caused by *Onchocerca volvulus*) cannot yet be determined.

Becker (P.). **The Behaviour of Larvae of *Culicoides circumscriptus* Kieff. (Dipt., Ceratopogonidae) towards Light Stimuli as influenced by Feeding, with Observations on the Feeding Habits.**—*Bull. ent. Res.* **49** pt. 4 pp. 785–802, 9 figs., 22 refs. London, 1958.

The following is substantially the author's summary. The larvae of *Culicoides circumscriptus* Kieff. are mostly negatively phototactic when removed from mud and put in water. Laboratory experiments showed, however, that if they are kept without food for a time, many become positively phototactic. The provision of food causes reversion to a photonegative taxis, which may be permanent as long as suitable food is given, or temporary if the food does not satisfy their nutritional requirements, but the provision of a completely non-nutritive medium does not bring about such a reversion. Most of the experiments were carried out with batches of fourth-instar larvae, but third-instar larvae and fourth-instar larvae near to pupation were used in a few. From the results, it is suggested that the processes of ecdysis and pupation may bring about a reversal from photonegative to photopositive taxis independent of the need for food.

It is assumed that the function of the behaviour of the larvae towards light stimuli is to maintain the larvae on the surface of the mud while they are feeding and to drive them below when they have fed, and that some other type of tropism must initially drive them to the surface or keep them below according to their nutritional needs. In *C. maritimus* Kieff., the photopositive tendency developed is not so strong as in *C. circumscriptus*, affecting fewer larvae, developing more slowly, and lasting longer. This may be because larvae of *C. maritimus* tend to burrow more deeply and to occur where the roots of reeds make the soil firmer, and so may find more food below the surface.

A second series of experiments with *C. circumscriptus* designed to throw light on the food requirements of the larvae is described. In a discussion of

the results, it is shown that the larvae feed on material both on and below the surface of the mud, and it is suggested that larvae that have fed on sub-surface food become positively phototactic when they need food from the surface, and, having fed there, again become photonegative. If, however, photopositive larvae have not previously had the opportunity to feed on sub-surface material, they continue to act as completely starved larvae and remain photopositive in spite of their having fed on surface material; such a contingency would not arise in nature.

The detailed constituents of the larval diet have not been worked out. The larvae appear to be detritus feeders, feeding mainly on vegetable matter and bacteria obtained on or below the surface of the mud, though green algae are not an important part of their diet. They are carnivorous on occasion but are normally not so when other food is readily available. They are selective in their choice of food and at least three factors, sapidity, texture and the size of particles, appear to influence the selection.

Kilpatrick (J. W.) & Schoof (H. F.). **A Field Strain of Malathion-resistant House Flies.**—*J. econ. Ent.* **51** no. 1 pp. 18–19, 2 refs. Menasha, Wis., 1958.

An account is given of observations on the development of both behaviouristic and physiological resistance to malathion in a field strain of house-flies [*Musca domestica* L.] at Savannah, Georgia. This is the first record of resistance to an organic phosphorus compound in house-flies in the United States. During 1954 and 1955, three applications of a spray of malathion and sugar were made to one dairy (A) and two to another (B), all at 200 mg. malathion per sq. ft. Dairy A also received an application of Dipterex [dimethyl 2,2,2-trichloro-1-hydroxyethylphosphonate] at 100 mg. per sq. ft. with sugar, while dairy B was given routine malathion bait treatments in the latter part of 1955. The same dairies were used from about the middle of May 1956 for studies on the effectiveness of poison baits applied on a routine schedule at permanent bait stations. A commercial bait containing 2 per cent. malathion was exposed in plywood trays, 2 ft. square, at 12–16 sites where fly concentrations were high outside the milking barn, to give a dosage of 4 oz. bait per 1,000 sq. ft. floor area. It was renewed twice weekly to reduce fly populations to control levels and once a week thereafter. Control was evaluated by grill counts [*R.A.E.*, B **38** 158], 0–10 being rated excellent and 11–20 satisfactory. At dairy A, excellent control was immediately obtained and only one application per week was needed for some time after the second post-treatment week. At dairy B, treatment twice weekly had to be continued for three weeks, and satisfactory control was not obtained until permanent bait stations (4 × 12 in.) were also established inside the milking barn. A week after this was done, excellent control was effected, and it was maintained for the remainder of the fly season except for one week. At dairy A, however, excellent control was maintained only until the beginning of August, when populations began to increase despite resumption of twice-weekly treatments, and control was not even satisfactory by the middle of the month. Other malathion bait formulations also failed to give control.

In tests of the attractiveness of baits in September, the numbers of house-flies at dairy A and (in brackets) dairy B found in each of the first five minutes following bait exposure were 0 (13–27) on a dry commercial bait containing 2 per cent. malathion and 0 (2–5) on an experimental liquid bait containing 2 per cent. malathion and 10 per cent. sugar, but 52–>200 (2–11) on a similar bait in which malathion was replaced by 1 per cent. DDVP [dimethyl 2,2-dichlorovinyl phosphate]. When the same malathion baits

were evaluated at other dairies round Savannah and near Orlando, Florida, they were found to be highly attractive. Further laboratory tests by R. W. Fay, J. W. Kilpatrick & G. C. Morris showed that flies from dairy A were less susceptible to malathion-sugar deposits on plywood panels than were flies of a laboratory strain and that when topical applications of a malathion-acetone solution were made to adult females three days old, the LD50's were 1·2 and 0·5 μg. per fly, respectively, for the two strains, and the amounts required for complete kill 7 and 1 μg.

Schoof (H. F.) & Kilpatrick (J. W.). **Organic Phosphorus Compounds for the Control of resistant House Flies in Dairy Barns.**—*J. econ. Ent.* **51** no. 1 pp. 20–23, 3 graphs, 8 refs. Menasha, Wis., 1958.

In 1956, the effectiveness of organophosphorus compounds as sprays for the control of house-flies [*Musca domestica* L.] resistant to chlorinated-hydrocarbon insecticides was investigated in dairy barns near Savannah, Georgia. The materials tested were diazinon [O,O-diethyl O-2-isopropyl-4-methyl-6-pyrimidinyl phosphorothioate], Dipterex [dimethyl 2,2,2-trichloro-1-hydroxyethylphosphonate], Dow ET-15 [O-methyl O-2,4,5-trichlorophenyl phosphoramidothioate], EPN [O-ethyl O-p-nitrophenyl phenylphosphonothioate], parathion and DDVP [dimethyl 2,2-dichlorovinyl phosphate]. All formulations were water emulsions, except that Dipterex was used as a solution in water and a combination of DDT and EPN as a suspension. Finished sprays were applied at 1 U.S. gal. per 1,000 sq. ft. Results were assessed by means of grill counts [*R.A.E.*, B **38** 158], counts below ten being rated excellent and counts below 20 satisfactory.

Applications of diazinon at 100 mg. per sq. ft. alone and with 250 mg. sugar gave control that was at least satisfactory for 6–8 weeks. Diazinon at 20 mg. per sq. ft. failed to give control without sugar but reduced populations satisfactorily for four weeks with 50 mg. sugar per sq. ft. Dipterex at 100 mg. per sq. ft. gave satisfactory control for three weeks alone and for eight weeks with 250 mg. sugar. A formulation containing parathion and DDT applied at 10 and 200 mg., respectively, per sq. ft. gave satisfactory control for one and five weeks in two dairies and satisfactory to excellent control for seven weeks in another. Parathion and sugar at 10 and 250 mg. per sq. ft. gave only one week of excellent control. In single tests, the combination of EPN and DDT at 25 and 200 mg. per sq. ft. gave excellent control for the whole evaluation period (13 weeks), and Dow ET-15 applied late in the season at 200 mg. per sq. ft. provided excellent control for nine weeks. DDVP with Aroclor 1256 [a chlorinated polyphenyl] used in one dairy barn at 100 and 400 mg. per sq. ft. [*cf.* **44** 105] gave excellent control for two weeks, but flies rested on treated surfaces for one hour or more without knockdown only a few days after treatment, indicating that control was largely due to space-spray action. Populations rose so much after two weeks that poison baits were used.

Parker (D. D.). **Seasonal Occurrence of Fleas on Antelope Ground Squirrels in the Great Salt Lake Desert.**—*J. econ. Ent.* **51** no. 1 pp. 32–36, 3 figs., 8 refs. Menasha, Wis., 1958.

Since fleas from the antelope ground squirrel (*Citellus leucurus leucurus*) in the area of the Great Salt Lake Desert have been found naturally infected with *Bacterium* (*Pasteurella*) *tularense* [*cf. R.A.E.*, B **47** 10], and since both the insects and their host have been known to harbour plague bacilli in nature, a study was made of the seasonal fluctuations in numbers of these

fleas. Antelope ground squirrels trapped alive between March 1955 and March 1956 in Utah in the Great Salt Lake Desert were found to be infested mainly with three species of fleas. These, in order of decreasing abundance, were *Thrassis bacchi gladiolis* (Jordan), *Hoplopsyllus anomalus* (Baker) and *Rhadinopsylla heiseri* (McCoy). *T. b. gladiolis* was taken in every month of the year. It was most abundant (with an index of 34·4 per host) in December, and least so in September (3·4) and showed a secondary peak (21) in April and May. *H. anomalus* was most abundant during the warm summer months with the highest index (23·7) in August and was not found from December to March inclusive. *R. heiseri* was collected mainly in December. Except for a sudden fall in January, the numbers of *T. b. gladiolis* rose during the months when the mean monthly temperature was below 64°F. and the mean relative humidity above 40 per cent., and fell when the temperature was above and the humidity below these figures; the numbers of *H. anomalus* tended to show the reverse of this relationship. Females of both species predominated over males in all months, except occasionally when the infestation rate for the species was low. Male antelope ground squirrels were more heavily infested than females.

Piquett (P. G.), Alexander (B. H.) & Barthel (W. F.). **A Study of certain Acetals as Synergists for Pyrethrins or Allethrin in House Fly Sprays.**—*J. econ. Ent.* **51** no. 1 pp. 39–40, 7 refs. Menasha, Wis., 1958.

A list, showing chemical structure and physical properties, is given of 17 synthetic acetals tested in space sprays by the turntable method [*R.A.E.*, B **26** 246] against house-flies (*Musca domestica* L.) as synergists for pyrethrins or allethrin. Nine contained the 3,4-methylenedioxyphenyl group, the importance of which in forming compounds with synergistic activity has been demonstrated by various workers [*cf.* **46** 137, etc.], and the other eight contained a 2,3- or 3,4-dimethoxyphenyl group in its place. They were tested at 5 mg. per ml. with 0·5 mg. pyrethrins in comparison with 1·3 mg. pyrethrins alone and at 2·5 mg. per ml. with 0·25 mg. allethrin in comparison with 0·67 mg. allethrin alone, and similar mixtures were tested with piperonyl butoxide as the adjunct. The nine compounds containing the 3,4-methylenedioxyphenyl group were effective with both pyrethrins and allethrin, but the other eight were not. Those sufficiently promising, as compared with piperonyl butoxide, to warrant further testing were 4-(1-(2-(2-ethoxyethoxy)ethoxy)ethoxy)methyl-1,2-methylenedioxybenzene, 4-((3-(1-(2-ethoxyethoxy)ethoxy)ethoxy)-2-methyl)propyl-1,2-methylenedioxybenzene, 4-(1-(2-(2-ethoxyethoxy)ethoxy)ethoxy)methyl-1,2-methylenedioxy-5-propenylbenzene and 5-allyl-4-(1-(2-(2-ethoxyethoxy)ethoxy)ethoxy)methyl-1,2-methylenedioxybenzene.

Knapp (F. W.) & Knutson (H.). **Reproductive Potential and Longevity of two relatively isolated Field Populations of Insecticide-susceptible House Flies.**—*J. econ. Ent.* **51** no. 1 pp. 43–45, 3 refs. Menasha, Wis., 1958.

Differences in the biology of various populations of *Musca domestica* L. with different histories of insecticidal treatment have often been recorded in the literature. An account is given of an investigation undertaken to determine the extent of biological variation between two relatively susceptible, isolated field populations of the fly from Ellsworth (E) and Wilmore (W), two localities about 110 miles apart in Kansas. The two populations had

LD50's of 3·7 and 2·7 μg. DDT per fly, respectively, as compared with one of 3 μg. for a non-resistant laboratory strain, the values being obtained by topical application. Collections of several hundred flies were taken to the laboratory, mass rearing was carried out, and daily records were maintained of the numbers of eggs laid, the length of adult life and the numbers of eggs hatching, of larvae pupating and of adults emerging. The following is based largely on the authors' abstract of the results.

The E females laid substantially more eggs during the first nine days of life than did the W flies, principally because, except for the first three days, they laid more eggs per day during that period, but also because more survived. However, the W females laid considerably more eggs per day later in life than did the E females, and the total numbers produced by the two groups were similar. Comparatively fewer of the eggs laid by the E than by the W females in the first nine days hatched, chiefly because a high percentage of the W eggs hatched during the second and third days, but more of the E than of the W eggs hatched during the second nine days. Totals for the first 27 days of the parents' lives were not significantly different, and the numbers laid thereafter were negligible. The percentages of larvae pupating and of pupae emerging were lower in the E population produced during the first two nine-day periods and for the entire 27-day period of the parents' lives. The E and W populations produced, respectively, 24·3 and 49·8 adult offspring per female parent, the difference being due primarily to the high survival of individuals from the W eggs laid during the second and third days and during the second nine-day period of the lives of the parents.

Eddy (G. W.), Hopkins (T. L.) & Robbins (W. E.). **Resistance of *Culex tarsalis* Coq. to DDT in Oregon.**—*J. econ. Ent.* **51** no. 1 pp. 56–58, 19 refs. Menasha, Wis., 1958.

In 1951, larvae of *Culex tarsalis* Coq. from areas of California in which DDT had been used against this mosquito were found to be about ten times as resistant as larvae from untreated areas [*R.A.E.*, B **41** 48]. DDT has also been the principal insecticide used in mosquito control in Oregon for several years, but no resistance has been reported there so far as known. The most extensive and sustained programme involving *C. tarsalis* in Oregon was initiated in 1953 in Lane County, where log ponds [**46** 197] produce very large numbers of mosquitos of this and other species. DDT was used effectively through the 1955 season except in one pond. Here, control was poor near the end of the season and again during the summer of 1956. A laboratory colony of the strain was established, and an account is given of experiments in which the larvae were shown to be at least 1,000 times as resistant to DDT as a non-resistant laboratory colony on the basis of the LC50, and more than 5,000 times on the basis of the LC90. The LC50 for fourth-instar larvae of the non-resistant colony was 0·003 part per million, whereas 50 p.p.m. gave only 82 per cent. kill of the resistant larvae of the first generation and was still required for complete mortality of the 11th generation, after which some loss of resistance was noted. The resistance indicated was probably only an approximation, as precipitation on the surface from the higher concentrations of DDT in acetone added to the water may have interfered with breathing or other activities of the larvae. Resistance appeared to be greater in newly hatched than in fourth-instar larvae.

The colonies were reared by methods adapted from those of Brennan & Harwood [**43** 198] and Hubert, Rush & Brennan [**44** 59]. Larvae were reared in white enamel pans about 13¼ in. in diameter and 4¼ in. deep in a

room maintained at 78–80°F. The adults were kept in an adjoining room (7 × 9 × 10 ft.), maintained at 75°F. and 70 per cent. relative humidity, and with a window space of 27 × 48 in.; no attempt was made to control the period or amount of light. Females were allowed to feed on fowls twice weekly and males were supplied with sugar water.

Cutkomp (L. K.) & Harvey (A. L.). **The Weight Responses of Beef Cattle in Relation to Control of Horn and Stable Flies.**—*J. econ. Ent.* **51** no. 1 pp. 72–75, 3 figs., 6 refs. Menasha, Wis., 1958.

The following is based largely on the authors' summary. To determine the effect of control of biting flies on weight changes in beef cattle, lots of four sprayed and unsprayed grazing cattle segregated by an electrified fence were compared at an experiment station in Minnesota in the summers of 1954, 1955 and 1956. The predominant flies were *Siphona irritans* (L.) and *Stomoxys calcitrans* (L.). The cattle used in each year weighed from 600 to slightly over 900 lb. at the beginning of the season and were treated on at least 50 consecutive days with a two-nozzle automatic treadle sprayer [*cf. R.A.E.*, B **39** 153; **44** 54]. The upper nozzle sprayed the back and the lower one the lower legs. Most of the formulations used contained pyrethrins and a synergist, with or without a repellent, in an oil base. They reduced *Siphona* populations by at least about 95 per cent. in each year and *Stomoxys* generally by nearly 40–70 per cent. Pyrethrins with piperonyl butoxide or MGK-264 [N-(2-ethylhexyl)bicyclo(2.2.1)-5-heptene-2,3-dicarboximide] gave satisfactory fly control. Addition of butoxypolypropylene glycol (Crag Fly Repellent) allowed reduction of pyrethrins from 0·54 to 0·23 per cent. without loss of efficiency, and resulted in gains of weight per animal per day in lb. throughout the season (mid-June to mid-September) in treated animals of 0·73 in 1954 and 1·3 in 1955 as compared with 0·48 and 0·63 for no treatment; the differences were significant for each year. In 1956, the untreated cattle gained more than the treated, but variation between individuals within groups was great and the difference was not significant. Differences between the years did not depend on the degree of fly control or the intensity of attack by biting flies, but appeared to be related to decreased benefit from fly control when the weather was cool and damp and forage abundant. From the economic value of the weight gains effected in 1954 and 1955 and the weather records, it is concluded that a profitable return from spraying may be expected in most years.

Gersdorff (W. A.) & Piquett (P. G.). **Relative Toxicity to House Flies of the *cis* and *trans* Fractions of Allethrin and the Intensity of Synergism of their Mixtures with Piperonyl Butoxide.**—*J. econ. Ent.* **51** no. 1 pp. 76–78, 8 refs. Menasha, Wis., 1958.

Biological methods of assay originally indicated that the *cis* and *trans* isomers of a distilled sample of allethrin represented about 69 and 31 per cent. of the whole [*R.A.E.*, B **41** 125], whereas chemical assay indicated that they comprised 25 and 75 per cent. [**43** 86]. It has since been shown that though the *trans* fraction used for the biological assay was authentic, the purity of the *cis* fraction was in doubt. Tests were made with a new authentic sample of the *cis* fraction [**45** 72], a sample of the *trans* fraction and allethrin itself to determine their relative toxicities to *Musca domestica* L. and the intensity of synergism of their 1:10 mixtures with piperonyl butoxide when applied as kerosene sprays by the turntable method [**26** 246]. The sample of allethrin was 93·4 per cent. pure. The ratio of the toxicity

of *cis*-allethrin to that of allethrin was 0·55, and the new estimation of the ratio for *trans*-allethrin and two previous estimations [**41** 125; **46** 79] furnished a mean of 1·19. On the basis of these two evaluations, the *cis* and *trans* fractions were calculated to comprise, respectively, 30 and 70 per cent. of the sample of allethrin, an estimate that agrees very well with that obtained chemically. On the basis of pyrethroid equivalents, the ratios of toxicity of the mixtures of *trans*-allethrin, *cis*-allethrin and allethrin itself with piperonyl butoxide to that of allethrin alone were, respectively, 2·94, 1·33 and 2·55. Synergism was demonstrated in all three mixtures, its intensity ratio for each ranging between 2·4 and 2·7 at the 50 per cent. and being 3·7 at the 95 per cent. mortality levels. All sprays caused more than 90 per cent. knockdown.

Levin (I.), Kugler (H. W.) & Barnett (H. C.). **An Automation System for Insectaries.**—*J. econ. Ent.* **51** no. 1 pp. 109–111, 3 figs. Menasha, Wis., 1958.

The authors describe and illustrate an apparatus designed to control the operation of various types of electrically driven insectary equipment automatically, according to an integrated 24-hour schedule. It was built for use at Washington in the rearing of exotic species of mosquitos, such as *Culex tritaeniorhynchus* Giles, from Japan, and *C. gelidus* Theo., from Malaya, which involved complex use of air conditioners, humidifiers, fans and both incandescent and fluorescent lamps. In addition to turning equipment on and off after varying intervals, the apparatus was designed to dim and brighten lights to the lower and upper limits of their capacities according to a regular schedule.

Harding jr. (W. C.) & Bissell (T. L.). **Lesser Mealworms in a Brooder House.**—*J. econ. Ent.* **51** no. 1 p. 112, 2 refs. Menasha, Wis., 1958.

In early September 1955, a heavy infestation of *Alphitobius diaperinus* (Panz.) developed in the maize-cob litter of a brooder house in Maryland [*cf. R.A.E.*, B **39** 155]. Of the chicks in it, 135 had died by the time they were ten days old, and about 40 of these were infested by the Tenebrionid. Observations showed that the larvae bored into the flesh and internal organs of chicks that were dead or dying, but did not attack chicks that were healthy and moving about or those more than 2–3 weeks old. The chicks were excluded from two areas of the house, and one of these was treated with 0·5 per cent. DDT and the other with 0·7 per cent. malathion, both in emulsion sprays applied at 2·5 U.S. gal. per 144 sq. ft. The litter was 8 in. deep. Comparisons of populations in samples of litter taken before and four days after treatment showed that both sprays were effective in controlling the infestation, particularly in the top 4 in. of litter.

Schulz (K. H.), Crutkhow (C.) & Sitachitta (C.). **A Demonstration Project of Fly Control using "Chlordane" in a Monsoon Area, Thailand.**—*J. trop. Med. Hyg.* **60** no. 6 pp. 141–145. London, 1957.

Insanitary conditions in and near Chiengmai, in northern Siam, result in heavy fly infestation in the town, particularly in restaurants, and also at the slaughterhouse and in markets. A control campaign was therefore carried out in which improved refuse disposal was combined with the application of a chlordane spray. The spray contained an aqueous emulsion of 1 gal. technical chlordane and 9 gal. kerosene in 15 gal. 5 per

cent. soap solution, diluted with 10 gal. water for application, and was applied to surfaces on which the flies were observed to congregate. These included the floor and furniture in tea shops, restaurants and food stores, and also articles hanging from beams (on which flies rested at night), a six-foot strip of ground round the doors of food stores and sunlit patches of walls inside and out, the ground around stalls, trestles, stall tops and walls to a height of three feet in the markets, and the walls of the slaughter-house, all slaughter by-products and the shallow pits in which bones and paunch contents were buried.

One application of spray was made in July and August, before the monsoon, at a rate to give a deposit of 3 g. technical chlordane (60 per cent. active ingredients) per sq. metre, which was higher than the amount found adequate to kill flies (*Musca* and *Calliphora*) exposed on treated plywood panels for five minutes. There were no flies in public eating places for over two months after the treatment, but re-infestation then occurred, chiefly because the monsoon floods had washed away or covered the deposits (experimental panels were still toxic) and the improved refuse removal and disposal system had also deteriorated. A second application was made at a slightly higher rate to about half the treated premises after the monsoon, in December, with no additional sanitary measures, and was effective for a shorter time.

Wegner (Z.) & Przyborowski (T.). **Ectoparasites of Rats in the Port of Gdynia.**—*Bull. Inst. mar. Med. Gdańsk* **9** no. 3–4 pp. 167–179, 2 figs., 1 map, 1 fldg. table, 43 refs. Danzig, 1958. (With Summaries in Russian & Polish.)

The ectoparasites of rats caught in several different environments in and near the port of Gdynia were investigated between March 1956 and March 1957. Of the 376 rats examined, 321 were *Rattus norvegicus* and 55 *R. rattus*, and 71·96 per cent. of the former and 78·18 per cent. of the latter were infested. Of the 1,557 ectoparasites taken on *R. norvegicus* and the 167 on *R. rattus*, 85·7 and 79 per cent., respectively, were lice (*Polyplax spinulosa* (Burm.)), 10·4 and 13·8 per cent. fleas and 3·9 and 7·2 per cent. Acarina. The fleas were nearly all *Nosopsyllus* (*Ceratophyllus*) *fasciatus* (Bosc), but one male of *Ctenophthalmus agyrtes* (Hell.) and one female of *Xenopsylla cheopis* (Roths.) were found on *R. norvegicus*. The female of *X. cheopis* was found on a rat caught in a residential part of the city bordering on the port. *N. fasciatus* occurs in various parts of Poland, and attacks rats, mice and occasionally man.

Papers noticed by Title only.

Rioux (J. A.). **Les Culicides du " Midi " méditerranéen** [southern France]. **Étude systématique et écologique.**—*Encycl. ent.* (A) **35,** [5 +] 303 pp., 185 figs., 13 pp. refs. Paris, P. Lechevalier, 1958. Price *Fr.* 7,000.

Senevet (G.). **Les anophèles du globe. Révision générale.**—*Encycl. ent.* (A) **36,** [4 +] 215 pp., 32 pp. refs. Paris, P. Lechevalier, 1958. Price *Fr.* 3,000.

Jacobson (M.). **Insecticides from Plants. A Review of the Literature, 1941–1953.**—*Agric. Handb. U.S. Dep. Agric.* no. 154, [4 +] 299 pp., 236 refs. Washington, D.C., 1958. [*Cf. R.A.E.*, A **47** 72.]

Rich (G. B.). **The Ear Tick, *Otobius megnini* (Duges) (Acarina: Argasidae), and its Record in British Columbia.**—*Canad. J. comp. Med.* **21** no. 12 pp. 415–418, 2 refs. Quebec, 1957.

The first record of *Otobius megnini* (Dugès) in Canada was from the ear of a domestic cat in British Columbia in 1941, but it has since been found to be widely distributed in the eastern part of the Province south of 52°N. lat., infesting mountain goats [*Oreamnos americanus*], mountain sheep [*Ovis canadensis*], various deer and domestic cattle. Although extensive inspections have been made in flocks in areas in which cattle and deer are infested, it has not been found in domestic sheep. Ten cattle are believed to have died as a result of infestation by it in British Columbia in 1954–56. Symptoms are "head-heaviness" and loss of appetite, followed by loss of muscular co-ordination and collapse. One case is known of recovery after the onset of symptoms followed by removal of the ticks. No abnormalities were found during autopsy or by sectioning nerve and brain tissue of a laboratory-infested calf. The parasitic stages are the larvae and nymphs. The nymphs are the most often seen, but as they occur only inside the host's ears, they generally go undetected. They may remain in the ears of the host for over 200 days, after which they fall to the ground and moult to the adult stage. The adults, which do not feed, mate, and the females subsequently lay batches of eggs at intervals of a week or more.

Wharton (G. W.) & Cross (H. F.). **Studies on the Feeding Habits of three Species of Laelaptid Mites.**—*J. Parasit.* **43** no. 1 pp. 45–50, 7 refs. Lancaster, Pa., 1957.

As *Laelaps jettmari* Vitzthum has been considered as a possible vector of haemorrhagic fever in Korea [*R.A.E.*, B **43** 162] and practically nothing is known of the feeding habits of Laelaptine mites, three species (*L. nuttalli* Hirst, *L.* (*Echinolaelaps*) *echidninus* Berl. and *Haemolaelaps glasgowi* (Ewing)) were studied in the laboratory in Maryland. All belonged to strains originating in the United States. The mites were aspirated into glass tubes and put on the skin of a host to feed or fed through a bolting-silk membrane [**43** 195]. Adults of *Haemolaelaps* and adults and nymphs of the other species were fed through the membrane on whole blood and blood fractions (red cells, plasma and serum) of chicken, rat and mouse; they all fed readily and showed no definite preference for a particular kind of blood or blood fraction. Temperature appeared to have a marked effect on feeding and its effect was different in the different species. *L. echidninus* fed better at high (95–105°F.) and low (65–70°F.) temperatures than at intermediate ranges (75–85°F.), and *L. nuttalli* and *H. glasgowi* at temperatures above 85° and 75°F., respectively, than at lower ones. Nymphs of the two species of *Laelaps* seemed to be affected in much the same way as adults. At 95°F., more mites of all three species fed at a low relative humidity (22 per cent.) than at higher ones (83 or 96 per cent.) but the only significant differences were those shown by nymphs and adults of *L. echidninus* at 96 per cent.

These mites are easily cultured on small rodents and obtain blood from them, but none was seen to feed on the undamaged skin of a host (rat, man or chicken). All three species fed readily on abraded human skin, however, inserting their mouth-parts into the dermis, and two of 20 examples of *L. echidninus* fed on a rat of which the skin had not been artificially abraded but was not known to be undamaged. Even if starved, the mites would wander on and off the host apparently at random, but as they would cluster

about abraded skin to feed and the skin of man is seldom completely unbroken, it is likely that contact with a large number of mites will result in at least a few bites. The fact that *L. nuttalli* feeds on man under certain conditions suggests that its potentialities as a vector of endemic typhus [*cf.* **40** 189] should be investigated and also lends support to the suggestion that *L. jettmari* may transmit haemorrhagic fever.

Gadalin (Yu. I.), Gershkovich (N. L.), Gorchakovskaya (N. N.) & Levit (A. B.). **The Problem of the Destruction of *Ixodes persulcatus* Sch., the Vector of Tick-borne Encephalitis, in its natural Environment.** [*In Russian.*]—*Byull. mosk. Obshch. Isp. Prir.* Otd. biol. **62** pt. 2 pp. 43–49, 3 figs., 6 refs. Moscow, 1957. (With a Summary in English.)

Work begun in the Kuĭbyshev region in 1951 [*cf. R.A.E.*, B **44** 153] showed that a spring treatment of deciduous forest areas with dusts, suspensions or emulsified solutions of DDT or BHC at rates affording 0·6–3 oz. technical compound per 100 sq. yards led to the almost complete cessation of attacks on man by *Ixodes persulcatus* Schulze in two days and a seasonal diminution of the population of adult ticks, as compared with untreated areas, of 96–100 per cent. The immature stages were also affected. The numbers of larvae and nymphs taken on *Clethrionomys glareolus* in the middle of small plots (2½–5 acres in extent) treated with DDT at 1·8–3 oz. per 100 sq. yards decreased by 58·2 and 54·5 per cent., respectively, and those in the middle of larger plots (100 acres) treated in 1954, to which fewer rodents from neighbouring untreated areas presumably penetrated, fell by 91·7 and 71·5 per cent.

Investigations were made in 1955 on the rate of reinfestation in forest stands having a grass ground cover not exceeding 16 in. in height that had been treated in 1953 or 1954. Reinfestation would result from the carriage of larvae, nymphs or engorged females into the treated area by mammals or birds or the migration of hungry ticks, and from the reproduction or development of individuals that escaped extermination. The results showed that the rate of reinfestation depended on the rate of application and the duration of toxicity of the acaricide, the size and configuration of the treated area and the character of its surroundings. In special tests, ground litter dusted with DDT at 0·9 oz. per 100 sq. yards was found to be still toxic to ticks after a year. The most rapid reinfestation by adult ticks occurred on a plot of about 11 acres in which dusting with a mixture of DDT and BHC at 0·3 oz. of each compound per 100 sq. yards gave complete control of attacks on man in the year of treatment (1954). Its rapidity is attributed to the very low rate of application, since the amount of toxicant washed into the ground litter would not be enough to kill ticks resting in it and the amount on the surface would not kill larvae or nymphs brought in on animals in the second half of summer. Where larger amounts were applied, sufficient toxicant was carried into the litter by wind, rain, or melted snow to kill ticks below the surface. The influence of plot size was shown by more rapid reinfestation of a small (5-acre) plot that was treated with DDT at 3 oz. per 100 sq. yards than of a large (40-acre) plot treated at only 1·5 oz. Another large plot treated at only 0·9 oz. per 100 sq. yards and with a longer periphery bordering on untreated forest became reinfested only slightly more rapidly than the latter.

Reinfestation by larvae was rapid and much more so than by nymphs, which continued to decrease for a time. A female of *I. persulcatus* lays up to 8,000 eggs in favourable conditions, and the numbers of larvae found

largely reflect the numbers of engorged females introduced. By the spring of the year after treatment, the upper layer of the ground litter consists of leaves that fell in the preceding autumn, and these cover the DDT deposits, which have in any case been washed in by rain. Larvae that hatch at this time do not come into contact with the poison until they have engorged and entered the litter to moult. This leads to some mortality of larvae, and is probably followed by an even greater mortality of the resulting nymphs, since hungry larvae and nymphs are more susceptible to poisons than engorged or moulting ones. Rapid increase in the nymphal population is thus prevented.

The effect of autumn treatment was also investigated. A 5-acre plot was dusted with 10 per cent. DDT in October 1953 at a rate affording 1·5 oz. DDT per 100 sq. yards. A reduction of 92·3 per cent. occurred in the numbers of ticks taken during the following season, but the tick population was low in the area. A more reliable test was made in a heavily infested area in which two plots of about 17 and 15 acres were dusted with DDT at rates of 0·9 and 1·5 oz. per 100 sq. yards, respectively, in late November 1954, after the leaves had fallen, and the deposits remained visible on the litter until heavy rain fell in the middle of May. On 11th May, before the rain, the ticks had not resumed activity and were as numerous as on the control plot, but contact with the DDT had already occurred since examples taken to the laboratory died soon after. Numbers fell sharply after the rain, and a reduction of 87·7 per cent. was recorded for the season. A better result would probably have been obtained had the dust been applied while the leaves were still falling and rain still occurred, so that some of the DDT would have been carried below the surface. As it was, it remained on the surface throughout the winter, and hence had no effect on the ticks below.

Antonipulle (P.). **Some Field Observations on the Breeding Places of *Siphunculina funicola* (Diptera, Oscinidae) in Ceylon.**—*Ceylon J. Sci.* (Biol. Sci.) (N.S.) **1** pt. 1 pp. 1–5, 5 refs. Colombo, 1957.

Siphunculina funicola (de Meij.) is not known to breed in fruits, but its prevalence during particular seasons in the drier parts of Ceylon is commonly attributed to the ripening of certain fruits, especially palmyra (*Borassus flabellifer*). In 1948, two visits were made to the Batticaloa district, where the fly is believed to be responsible for a heavy incidence of conjunctivitis [*cf. R.A.E.*, B **19** 60] in September–November, in an attempt to locate its breeding places there. This district, which is on the east coast and in the dry zone, receives rain from October to January and sometimes in April and July. The flies are generally plentiful in June, July and August, and were abundant during the first visit, made between 12th August and 11th September 1948, but much less so during the second, from 5th to 28th October. During the two visits, 409 palmyra fruits and many fruits of other kinds were examined, as well as 970 possible breeding places of 34 other types, but breeding was found on only 18 occasions (five times in fish dressing places, three times in human excrement, six times in trenching grounds, and once each in cattle dung [*cf.* **16** 252], a palmyra fruit, a pumpkin-plant bed and saturated soil around a latrine [*cf.* **26** 94]). No breeding was found in 180 examinations of straw and coconut-leaf thatch; grass thatch [*cf.* **27** 206] is not used in Batticaloa. It is concluded that the breeding season must have been practically over when the investigation began, and that palmyra fruits are unlikely to be an important breeding medium, as they ripen and fall in August and September.

Kocher (C.) & Treboux (J.). **Über die insektizide Wirkung von Diazinonbelägen in Abhängigkeit der Brühenkonzentration.** [The insecticidal Effect of Diazinon Deposits in Relation to Spray Concentration.]—*Anz. Schädlingsk.* **30** pt. 7 pp. 104–107, 20 refs. Berlin, 1957.

An account is given of experiments in which house-flies [*Musca domestica* L.] of a laboratory strain resistant to DDT were exposed for two hours to the deposits resulting from applications of diazinon (O,O-diethyl O-2-isopropyl-4-methyl-6-pyrimidinyl phosphorothioate) at 200 mg. in 10–100 ml. spray per sq. metre and observed for knockdown at intervals during the test period. A wettable-powder and an emulsion spray were compared on both paper and leaves, the flies being exposed at intervals of 1–13 days after application of the sprays, and the results showed that effectiveness increased in general as the quantity of spray in which the insecticide was applied decreased. The increase in effectiveness was greater on the leaves, particularly for the wettable-powder sprays. A possible reason for the increase was that the diazinon in the smaller quantities of more concentrated spray was deposited discontinuously in droplets, so that it had a more rapid effect than in the even films resulting from the greater quantities of weaker spray, and vaporised less rapidly; furthermore, large quantities of water are thought to accelerate the vaporisation of diazinon.

The difference in effectiveness was much less when wettable-powder sprays containing both diazinon and DDT were applied to wood and paper and the flies exposed to the deposits 1–60 days later. This is attributed partly to a stabilising effect of the DDT on diazinon.

Hyde-Wyatt (B.). **The Control of an isolated Tsetse Population.**—*W. Afr. med. J.* (N.S.) **6** no. 2 pp. 68–69, 3 refs. Ibadan, 1957.

Tsetse flies of the group of *Glossina palpalis* (R.-D.) occur in the vegetation around permanent streams and water holes in northern Ghana, and can be eradicated by clearing [*cf. R.A.E.*, B **34** 18–19; also **42** 25], but in some places such as sacred groves, gardens and plantations, this method cannot be used. *G. tachinoides* Westw. and *G. palpalis* have occurred in small numbers for some time in a five-acre garden at Wa, containing fruit trees and bordered on one side by two permanent pools. A lorry park was established near the garden in 1956, and the number of flies taken in five Morris traps [**37** 110] rose from one per month in October 1955 to over 20 a week in August and September 1956. All vegetation that could afford cover was therefore given four applications of DDT from knapsack sprayers; in the first, made on 30th October, a suspension of 1 lb. wettable powder in 4 gal. water was used, but as this tended to clog the nozzles, the strength was halved in the subsequent ones, which were made on 5th November and 5th and 17th December. The rate of application was about 8 gal. per acre. The number of flies caught in traps fell within a week of the first application, and thereafter remained very low, seven adults of *G. tachinoides* being taken in each of the last two months of 1956, none in January 1957 and two non-teneral ones (more than seven days old) in February. On a weekly fly round, only one example of *G. palpalis* (a male) and three of *G. tachinoides* were taken in a total of 24 fly-boy hours between 17th November and 8th December and none after this. The flies taken in February may have been brought by lorries. Since only three females of *G. palpalis* were taken in traps during the period covered, one in August and two in September, the species was probably not established in the garden.

Robertson (A. G.) & Bernacca (J. P.). **Game Elimination as a Tsetse Control Measure in Uganda.**—*E. Afr. agric. J.* **23** no. 4 pp. 254–261, 1 map. Nairobi, 1958.

Little is known of the situation regarding the savannah game tsetses, *Glossina morsitans* Westw. and *G. pallidipes* Aust., in Uganda prior to 1920, but a condition of unstable equilibrium appears to have existed between these flies and the game animals on the one hand and the pastoralists and their cattle on the other. The instability was mainly due to periodic outbreaks of rinderpest, but two new factors that came into operation after 1920 were the reduction in the numbers of elephants and restriction of their long-established movements, and the institution of early grass-burning as part of the policy against erosion [*cf. R.A.E.*, B **47** 45]. These allowed much of the open fly-free country to become sufficiently overgrown with bush to harbour the flies, and their next extension, which began about 1935, resulted in the loss of nearly 8,000 sq. miles of cattle country by 1944 [*cf.* **34** 152]. There was no natural barrier to prevent further spread, so that the whole cattle industry of the Protectorate was threatened. There was also danger that an extension of the range of *G. pallidipes* westward from Bugerere would spread sleeping sickness, caused by *Trypanosoma rhodesiense* [**33** 101], through the Protectorate. The need for a control organisation was thus evident.

Preliminary surveys and observations by the entomological section of the Medical Department led to the initiation of active control measures against *G. pallidipes* in Buruli in 1944. These consisted of halting the southward movement of buffalo by shooting, which was later extended to the smaller game animals, controlled fierce late burning of the grass to delay and if possible reverse the thickening of the bush and to facilitate hunting, and reduction of the population of bush-pig [*Potamochoerus porcus*] by organised tribal hunts. As a result, the southward advance of the fly was stopped and turned into a retreat, and this success led to the establishment of an extensive and separate control organisation, which began its work in 1947, continued the above measures with a strictly limited amount of subsidiary bush clearing, and extended them over the greater part of the infested area (6,300 sq. miles). This area consisted chiefly of long-grassed *Combretum* woodland with thickets ranging in size from small termite-mound clumps to blocks of a square mile or more. The operation was highly successful and had resulted by 1957 in halting at least two major advances of *G. pallidipes* and one of *G. morsitans*, reclaiming some 4,800 sq. miles from both species and making good progress in the reclamation of the remaining 1,500 sq. miles. All ungulate game animals were shot except giraffe and two species of antelope; elimination of elephant, where necessary, was carried out by the Game Department. In all, the hunters killed a total of 27,421 animals in an area of about 4,500 sq. miles. The area not covered by game elimination (1,700 sq. miles) was reclaimed during 1947–52 by selective clearing, which was economic there because the fly (*G. morsitans* only) was distributed sporadically in predominantly short-grassed woodland.

Important features of the organisation were that only good shots were selected as hunters, and these were well paid, independently of the numbers of animals shot, which with close supervision ensured that hunting continued with enthusiasm until game densities were reduced to a level low enough to effect eradication of the fly. The work was generally facilitated, and the use of game fences to prevent reinvasion of the country was never necessary, because the division of the country into discrete blocks by large rivers and lakes allowed working to natural barriers with no shooting front of over 70 miles, and it was possible eventually to reach predetermined lines which could be consolidated as barriers of clear settled country across the

former avenues of the tsetse advances. The cost of the operations was estimated at approximately two shillings an acre; this contrasts with the cost of bush-felling against *G. pallidipes*, which may well be 60 shillings an acre or more.

International Scientific Committee for Trypanosomiasis Research. Sixth Meeting, Salisbury 1956.—xii + 216 pp., illus., refs. [London] Comm. tech. Co-op. Afr. S. Sahara, 1958.

This report contains the original or translated texts of 31 papers submitted to the meeting, and the following are abstracts of those that deal with *Glossina* and the transmission of trypanosomiasis and of one other.

Du Toit (R.) & Kluge (E. B.). **Présence de *Glossina brevipalpis* Newst. autour du Lac Ste Lucie, au Zoulouland** (pp. 17–20, 1 map). Surveys for *Glossina austeni* Newst. by means of fly rounds, with bait cattle and pigs, were begun in June 1949 in Zululand on the western shore of St. Lucia Lake and of its western extension, False Bay. These revealed the presence of *G. brevipalpis* Newst. in January 1955, when two examples of this species were taken in the heavy bush [*cf. R.A.E.*, B **16** 129; **40** 91] on the shores of False Bay, and a third in the Hluhluwe garage about 6 miles to the west. As *G. brevipalpis* had not previously been recorded from the area and had been eradicated from the Hluhluwe game reserve [**44** 117], it was concluded that it must have been transported to the garage by a motor vehicle from the Pongola river some 80 miles to the north. Further searches with the bait animals revealed its presence not only in small numbers throughout the heavy bush bordering False Bay and St. Lucia Lake, but also in high concentrations at various points there. Searches for puparia carried out at the same time showed that these local concentrations were permanent breeding foci; in October 1955, more than 1,600 empty and 29 full puparia were found. These foci were associated with heavy bush and the presence of hippopotamus [*cf.* **38** 157; **46** 167], which visited the areas at night. The distribution and feeding habits of *G. brevipalpis* around St. Lucia Lake thus appear to resemble those along the Pongola and Maputo rivers in northern Zululand and Portuguese East Africa where it lives along the rivers and seems to feed exclusively on hippopotamus. Since the latter rarely leave the waterside except to graze at night, *G. brevipalpis* probably also feeds mostly at night. In this type of distribution, *G. brevipalpis*, apart from differences related to its shade and humidity requirements, resembles *G. pallidipes* Aust. in the regions that the latter formerly infested and could probably be eradicated from the whole region by the treatment of breeding foci and the destruction of adults in them with insecticides. Many domestic animals graze near the lake, which is saline, but as they do not have to go to the streams where the hippopotamus drink, trypanosomiasis of stock is extremely rare.

Glasgow (J. P.). **La nourriture de la mouche tsé-tsé** (pp. 21–24, 5 refs.). The results of the examination of more than 1,400 samples of blood from the stomachs of tsetse flies caught in various parts of East Africa [**46** 167] are summarised, but it is pointed out that although the serological technique was satisfactory, the entomological sampling was not. The usual catching methods depend on attracting hungry flies, so that the proportion of recently fed flies in the catch is very much below that in the whole population. Although by using enough catchers a large number of fed flies can be collected, these do not constitute a statistically satisfactory sample. Unknown factors might make flies that had engorged on a certain host easier or harder to catch than others. The location of resting adults of *G.*

swynnertoni Aust. was studied in Tanganyika [45 186], and samples of blood-meals from resting males, resting females and active males were obtained. The last form a control, having been collected in the same way as the earlier samples. It was found that 64 per cent. of active males and 86 and 87 per cent. of resting males and females in a sample taken in February had fed on Suid blood, from which it appears that Suids are even more important as hosts of *G. swynnertoni* than the former results indicated.

Bursell (E.). **Variations saisonnières dans l'humidité des gîtes à pupes de la glossine** (pp. 25–29, 1 graph, 3 refs.). The period from the hardening and darkening of the third-instar larva of *Glossina* to the emergence of the adult can be divided into three parts according to the rate of transpiration. During the first part, which includes the immobile period in the third instar and the whole of the fourth instar and lasts about five days at 25°C. [77°F.], water loss takes place both through the puparium and the supernumerary stigmata and is heavy. In the second part, which includes the pupal stage, the thin pupal skin is very impermeable, and though some water is lost through the stigmata, this loss is small; in spite of some slight increase during the period, the transpiration rate can be regarded as constant from the ninth to the eighteenth day. During the third period, the rate increases progressively until, 1–2 days before emergence, the pupal skin loses its impermeability and the puparium once more becomes the membrane limiting water loss. The rate of transpiration during the long intermediate phase is in some way linked with the amount of water lost during the earlier period. The drier the conditions during this earlier period, the lower the rate of water loss during the subsequent one.

This phenomenon makes possible the estimation of the humidity of natural breeding sites. Pupae taken from these are subjected to 0 per cent. relative humidity for six days and their water loss is recorded. The rate of water loss of such pupae as are 9–18 days old when subjected to treatment (identified by emergence dates) is then compared with that of reared groups exposed to various known humidities in their early stages. Another method is to construct a curve relating size (length × width) to weight at the beginning of the first stage, and to ascertain from it the original weight of pupae collected in the field; the amount of water lost during the first part of pupal life is represented by the difference between this and their weight on collection. Studies of this kind were made in a habitat of *G. morsitans* Westw. at Singida in central Tanganyika over a period of 14 months (two dry seasons and one wet season) in 1954–55. Transpiration rates during the main part of the pupal stage were low in the middle of the dry season, rose to a maximum at the height of the rains and fell slightly during the latter part of the rains. These changes can be reasonably interpreted as resulting from the effect of the annual rains on the soil humidity, but the subsequent maintenance of fairly high transpiration rates during the early part of the dry season, and the delay of their major fall until four months after the end of the rains, may perhaps be ascribed to the maintenance of soil humidity by stands of grass until the removal of their protection by the annual grass fires in the middle of the dry season. These trends are borne out by the records of the loss of weight sustained during early pupal life, which was greatest at the end of the dry season and least at the height of the rains. These transpiration rates indicated that the relative-humidity percentages in the pupal sites rose slightly above 98 during the rains, ranged between 80 and 95 between the end of the rains and the middle of the dry season, and fell to about 40 at the end of the dry season; at this season a similar value was obtained for the habitats of *G. swynnertoni* Aust. and *G. pallidipes* Aust. at Shinyanga. Laboratory experiments showed that the pupae of savannah tsetses (including *G. longipennis* Corti) can survive exposure throughout the

pupal period to humidities lower than this without increased mortality, so that such species are unlikely to be affected by seasonal changes in humidity in their natural habitats. In species such as *G. austeni* Newst., *G. brevipalpis* Newst., *G. tachinoides* Westw. [**23** 63] and *G. palpalis* (R.-D.) [**25** 93] on the other hand, the viability of the pupae is considerably reduced by relative humidity below 50 per cent. This is thought to explain the failure of *G. palpalis* to produce a second generation in a habitat of *G. swynnertoni* at Shinyanga [**34** 197–198]. Without detailed information on adult physiology, the importance of the moisture equilibrium of the pupa cannot be precisely assessed, but it seems that an attack on this stage of the humidity-loving species might be promising.

Glasgow (J. P.). **Les pièges dans l'étude de** *G. pallidipes* (pp. 31–33, 2 graphs). The author believes that traps have considerable value in population studies on *Glossina pallidipes* Aust. In Kenya, [B. J.] Duffy made catches with a series of Morris traps [**37** 110] situated in the open about 15 ft. from the eastern edge of a very large thicket believed to harbour 250,000 males of this species per sq. mile, and these were compared with catches on a fly round on the edge of a similar thicket close by. The round was carried out and the traps were emptied every two hours. The results obtained with 15 traps over a period of three weeks and corresponding results for the fly round are shown in histograms. Catches on the fly round showed more males than females and were more nearly constant throughout the day, though a small peak occurred at 4 p.m.; those in the traps showed about 80 per cent. females, low numbers in the morning and marked peaks at 2 p.m. for the females and at 4 p.m. for the males. The greater numbers caught in the afternoon were thought to be due to the appearance presented by the traps when the sun was behind the thicket, and catches on the west side of the thicket partly supported this, as their peak catching time was in the morning in some months, though not in all. It is presumed that the original hypothesis was correct, but that some unknown factor interfered at some seasons. The highest hand catches of males were made earlier in the east than the west. In May, a very wet month, these differences nearly disappeared and on both sides of the thicket the biggest trap catches were at 4 p.m. and the biggest hand catches of males at 2 p.m. Traps also provide a more accurate method than hand catching for studying dispersal, though it is not known to what extent the nearest traps of a series interfere with catches at more distant ones.

Willett (K. C.). **Les relations spécifiques de** *Trypanosoma rhodesiense* (pp. 35–50, 18 refs.). The following is based largely on the author's summary. The specific relations between *Trypanosoma rhodesiense*, *T. brucei* and *T. gambiense* are discussed with a view to elucidating the origin of *T. rhodesiense*. The failure of all experimental attempts either to make *T. brucei* infective for man or to make *T. rhodesiense* lose its infectiveness [**45** 83] is emphasised as proof of the stability of the distinction between the two species. The separation of *T. rhodesiense* and *T. gambiense* depends on a number of differences of degree, as for example a difference in virulence, and on the fact that the former is transmitted by species of *Glossina* of the group of *G. morsitans* Westw. and the latter by species of the group of *G. palpalis* (R.-D.). Examination of the accounts of a number of epidemics of sleeping sickness caused by *T. rhodesiense* showed that it had always either been imported from a known source or occurred where *T. gambiense* was already present and could have developed into a more virulent form, and that there is no need to postulate a mutation of *T. brucei* into *T. rhodesiense*. The history of the original appearances of sleeping sickness caused by *T. rhodesiense* is traced through quotations from the literature of the time, and the conclusion is reached that it developed from *T. gambiense* introduced by human carriers into areas of Rhodesia and Nyasaland in which

G. morsitans occurred and species of the *palpalis* group did not. The appearance of the virulent form of sleeping sickness in areas where *G. morsitans*, *G. swynnertoni* Aust. or *G. pallidipes* Aust. is present may be the result of selection, because these species transmit easily the virulent *rhodesiense*-like strains of *T. gambiense*, or of an alteration in the trypanosome resulting from repeated transmission through a species of the *morsitans* group.

Rennison (B. D.). **Taux d'infection des mouches tsé-tsés et estimation du nombre de trypanosomes nécessaires à l'infection** (pp. 51–60, 40 refs.). The determination of the incidence of trypanosomes in *Glossina*, though seldom carried out, is indispensable to the study of trypanosomiasis, and should be included even in short tsetse surveys, as the accumulated results would provide valuable data on rates of infection in different species under different conditions. The object of this paper is to promote discussion with a view to establishing agreed methods. Results of earlier work are reviewed. They show that the rates of infection depend on the species of tsetse and trypanosome and are influenced by the host animal, the age and sex of the fly, and climatic conditions. For a trypanosome survey, the tsetses can be caught by hand with or without bait, on whole rounds (sampling vegetation communities) or on line transects (following a given line taken at random) or they may be caught in traps; their infection can be determined by dissection, by feeding the tsetses on uninfected laboratory animals or by examination of stained saliva on slides [**37** 137]. Hand catches indicate the density of the fly in relation to its activity at the time of capture, so that they will give a satisfactory figure only when, by continuation throughout the day, they include flies in all stages of activity. This can also be achieved by using traps, but these show such individual differences that they need to be carefully sited and moved in rotation. They are the only means of catching adequate numbers of rare species, and should be used more extensively. The data obtained by hand catching can be standardised by calculating either in flies per boy-hour or in apparent density [*cf.* **42** 152]. The method of dissection should permit examination of the proboscis, gut and salivary glands. More complete identification can be obtained by staining. Feeding tsetses on small laboratory animals reveals only a minimum rate of infection and does not allow the detection of trypanosomes that cannot be transmitted to them, but it may be a precise method for the estimation of infections by the rare *brucei* group. Examination of stained saliva needs experience and patience when the infections are light but could be used to calculate the number of trypanosomes transmitted and the trypanosome challenge [a term used to denote the number of infective bites received by a host animal in unit time].

Tsetse surveys with examination of infections should be the method used in collection of data for the accurate assessment of the transmission rates of different species of fly at different seasons. E. F. Whiteside has produced a graph in which the monthly incidence of trypanosomiasis of stock in one district of Kenya is forecast within 3 per cent. on the basis of density of flies in the previous month, but the method is subject to error because it is based on apparent density only. The cause of the failure of an attempt to use it in another area where fly density was very low is briefly discussed.

From sufficient data on host, age and sex of flies and climatic conditions, it should be possible to estimate the rate of infection independently of the size of the fly population. However, as the population determines the rate of transmission, it should be measured precisely when it is desired to calculate the trypanosome challenge. With present methods, the percentage of infected flies can be ascertained within certain limits, but not the number of trypanosomes transmitted. Surveys for trypanosomes in places in which contact between stock and fly is close would help to relate infection and transmission rates, particularly if the catches are made on stock grazing in

tsetse-infested areas. As the trypanosome challenge constitutes the only means of measuring the dangerousness of the fly, all data contributing to a knowledge of it are of practical value in adding precision to present inadequate methods.

Steele (B.). **Rapport d'avancement d'un projet tendant à l'éradication de *Glossina brevipalpis* du District Karonga au Nyassaland** (pp. 91–101, 6 graphs (2 fldg.), 1 fldg. map, 2 refs.). In the Karonga District of the Northern Province of Nyasaland, *Glossina brevipalpis* Newst. occurs along the foothills bounding the lake plain from the Kasisi river northwards to Katumbi and Yembe Hill and, with a break caused by a cleared slope that has been brought into cultivation, extends to the Songwe valley and across the border into Tanganyika [*cf.* **27** 260]. There are no other known infested areas within 100 miles, and no other species of *Glossina* is established in the district. Outbreaks of trypanosomiasis of stock were numerous in 1947, and there was a recrudescence of *G. brevipalpis*, which had disappeared from the plains as a result of clearing for agriculture, but this did not recur. In 1948, B. L. Mitchell observed that the fly was concentrated in the ravines and never invaded the plain, and control by clearing of the ravines was attempted. As complete clearing was inadvisable because of soil erosion, and *G. brevipalpis* was thought to need a double canopy, clearing of the lower layer only was begun in 1950. The area from the Kasisi to Yembe Hill had been cleared by the end of the year, but regeneration was very rapid. Clearing had to be repeated at the end of the 1950–51 rainy season, and fly catches showed no decrease. Efforts to limit regeneration in 1951 were satisfactory in two small areas only. Complete clearance was therefore tried in four of the five ravines on the south slope of Yembe Hill in 1952. The numbers of tsetses fell considerably, and the clearing was repeated and extended to another area in the south in 1953, but no clearing was carried out in 1954. Tsetses decreased considerably in numbers in the cleared areas from 1954 onwards but did not disappear altogether. Vegetation round certain points where flies were invariably caught was destroyed completely, with encouraging effect. Although the results of clearing were in general disappointing, cumulative effects are becoming apparent. No fly was found in the southern area after the last clearing operations in August 1955, though some outbreaks of trypanosomiasis occurred each month even there. The disease is of a mild form attributable to *Trypanosoma vivax* and is presumably sufficiently widespread to be maintained by mechanical transmission. It is proposed to clear the north of Yembe Hill and to try selective eradication of the persistent flies. An attempt to clear *G. brevipalpis* from the Songwe valley would need co-operation from Tanganyika.

In view of the risk that the fly might migrate from a cleared to an uncleared area, the possibility of destroying it in known foci with an insecticide was investigated. A small wood was treated six times at intervals of ten days with fog produced from a 4 per cent. solution of γ BHC in diesel oil with a Swingfog machine [**44** 130], but flies were always found within about four days of treatment and large catches were once made on the ninth day, when a troop of monkeys arrived. The experiment indicated that insecticidal treatment is not very satisfactory and that there is a strong likelihood of reinfestation.

Incidental observations on ecology indicated that *G. brevipalpis* needs shade, but that this can be provided in very varied ways, often in the form of a double canopy, but also by thick scattered bushes, and a partially cleared rocky stream bed can give sufficient protection to allow survival; some vegetation may, however, be too thick [*cf.* **38** 220]. Catches were generally high during the rains in February or March and again in August. Puparia were never found, and female flies seldom. Marked flies were recovered in suitable country up to half a mile from the point of release,

though they were never taken in the plains, and clearing often caused catches to rise in neighbouring uncleared areas. Catches made by patrols are therefore difficult to interpret.

Robertson (A. G.) & Bernacca (J. P.). **L'élimination du gibier comme moyen de lutte contre la tsé-tsé en Ouganda** (pp. 103–122). The substance of this paper has been noticed from an English version published a few months earlier [**47** 37].

Chorley (J. K.). **La lutte contre la mouche tsé-tsé en Rhodésie du Sud** (pp. 123–137, 9 refs.). Organised game destruction for the control of *Glossina morsitans* Westw. [**40** 23, etc.] has been practised in Southern Rhodesia since 1919 [**7** 179], and the greater part of this paper consists of a discussion of the basic principles of the method [*cf.* **34** 103–104] and its operation. It depends on depriving the fly of its food supply, and also on maintaining an animal- and fly-free zone between known fly foci and restocked areas. The fly usually begins to decrease behind the zone of operations in about five years and eventually disappears altogether. Freedom of an area from fly can be claimed with reasonable assurance only if during two years no fly has been found and no cases of trypanosomiasis have occurred in introduced test herds of cattle. It has been found desirable to increase the width of the shooting zone, originally about ten miles, to 20 or 30 miles. Bush clearing and dense human settlement have never been adequately tried against *G. morsitans* in Southern Rhodesia. The problems in this connection raised by the large movements of African populations that are resulting from the application of the Land Apportionment Act and from the flooding of a region of the Zambesi valley by the construction of the Kariba dam are briefly discussed. Experiments in Urungwe with aerosols released from 4 per cent. γ BHC in oil and dispensed from the exhaust-pipe of an aircraft showed that eight applications at intervals of 28 days could not be made under good conditions at any time of year, and the results of large-scale work were disappointing in view of the success of similar operations on which this had been based, against *G. pallidipes* in Zululand [**44** 117]. However, the method was found to be useful in a small and carefully chosen area.

More recent surveys have shown that *G. pallidipes* Aust., which was found associated with *G. morsitans* in Sebungwe district in 1942 [**32** 24], is present in a large part of the Zambesi valley from the Chewore river in Urungwe district to the border of Wankie district. Its exact distribution is not known, nor is it known whether game destruction will be as effective against it as against *G. morsitans* [*cf.* **34** 104; **40** 147]. *G. pallidipes*, *G. morsitans* and *G. brevipalpis* Newst. all occur along the frontier of Portuguese East Africa [*cf.* **40** 24], and a clearing designed to restrict the entry of fly into Southern Rhodesia from Portuguese territory has not been completely effective in preventing trypanosomiasis of cattle from occurring in border farms, though it has kept the incidence very low.

Esteves-de-Sousa (A.). **Preliminary Experiments with Phytocides to control Stump Growth and thorny Bush Thickets in Areas infested with** *Glossina austeni* (pp. 163–172, 1 map, 10 refs.). Discriminative bush and forest clearing, with burning of the débris, temporarily freed large areas in the Lorenzo Marques district of Portuguese East Africa from *Glossina austeni* Newst., but stump regeneration soon provided a low dense canopy that allowed the fly to re-establish itself. A small-scale experiment was therefore made to determine whether commercial herbicides would prevent regrowth on stumps and control thorny shrubs that were invading pasture lands. Several preparations were tried, and the most effective contained a mixture of 2,4-dichlorophenoxyacetic acid and 2,4,5-trichlorophenoxyacetic acid, which was known to affect a wider range of plants than either alone. The acids were present in the form of esters to improve solubility. It is concluded from the results that effectiveness was related to concentration of

active acid equivalent, irrespective of chemical form. It was greater when oil rather than water was the solvent and when treatment was made at the beginning of the growing season rather than while the plants were dormant, though treatment of stumps during the dormant season usually inhibited regrowth.

Mitchell (B. L.) & Steele (B.). **A Report on the Distribution of Tsetse Flies in Nyasaland and some Recommendations for Control.**—67 pp., 8 fldg. maps in pocket, 1 fldg. chart in pocket, refs. Zomba, Govt. Printer, 1956.

This is a report of a survey of *Glossina* in Nyasaland made in 1950–54 by a team of temporary officers working under the Tsetse Entomologist of the Protectorate (the senior author). It includes an account of the methods used, a review of the main vegetational associations of Nyasaland showing their relationship to one another and to tsetse distribution, a summary of the findings and economic considerations involved, the recommendations made for control and a discussion of special problems. Half of the report comprises detailed descriptions of the individual tsetse belts.

Patrols searching for *G. morsitans* Westw. alone worked in the bush without extra aids, but where it was thought that *G. pallidipes* Aust. might exist, black screens and occasionally bait cattle or a bush-pig [*Potamochoerus porcus*] were used [*R.A.E.*, B **33** 100]. Footpaths and game trails were searched at sundown if the presence of *G. brevipalpis* Newst. was suspected [*cf.* **42** 150]. Only *G. morsitans* and *G. brevipalpis* were found. The local vegetational requirements of the former are apparently heterogeneous tree-cover in more or less intimate mixture, some short grass, and the absence of widespread human interference. Climatically, the lowest part of the area is marginal for tsetse on account of high temperatures, which are lethal at certain seasons. The fly then persists in small residual patches of forest and thicket. It occurs in three types of area, namely the Rift Valley floor, the lower part of the Rift wall and the upland plateau. The general distribution of *G. morsitans* as seen during the survey is shown on a map and discussed. At the time, the population of the fly was at a very low level at which it is not likely to remain. A forecast is made of the probable development of the situation in the absence of active control measures. *G. brevipalpis* needs dense cover, in which it shelters during daylight, leaving it in the evenings to feed. It has been located in riverine and other thicket patches along the lake-shore, in the Kota-Kota district of the Central Province, and occurs in a small belt centred on Yembe Hill in Karonga district in the Northern Province [**47** 42]. Unlike that carried by *G. morsitans*, the form of trypanosomiasis transmitted by *G. brevipalpis* there [*Trypanosoma vivax* (**47** 42)] is mild and does not constitute a serious hazard to stock. There is no history of serious sleeping-sickness epidemics in Nyasaland, but individual cases occasionally occur.

It was concluded from the survey that an enlightened policy of land settlement, related to the tsetse problems involved, was the correct and most economic method of controlling *Glossina* in Nyasaland. A land utilisation survey of the areas in which settlement is recommended in this report should be made as soon as possible and a detailed plan drawn up. Recommendations are made on particular local problems, and other possible control measures are discussed. These comprise the use of insecticides and traps, game extermination and discriminative clearing. Insecticides could not be used against *G. morsitans*, the wide distribution of which would make the cost prohibitive especially as there are no large herds of cattle to justify the

expense, but they might be useful against *G. brevipalpis*, which can be maintained by patches of dense double-storey forest half an acre or even less in extent. These can generally be cleared, but where they are used as burial groves, it would be desirable and practicable to treat them with insecticides as there is no risk of reinfestation provided the main belt has been cleared. No trap is known that will catch either species in sufficient numbers to reduce populations. Game extermination and discriminative clearing are of very limited application under Nyasaland conditions; the latter measure, the mode of action of which is not well understood, can be applied only to large tracts of vegetation of regular pattern, whereas the vegetational pattern of Nyasaland is very irregular. Its use should, however, be considered in conjunction with settlement, and areas in which this could be done are particularised.

Special problems discussed include the establishment of forest reserves, which may protect human populations from contact with tsetse where eradication is impracticable. Such reserves should have clear-cut edges and be surrounded by sufficiently dense settlement or drastic clearing to contain the fly, and roads, railways and paths through them should be protected by clearings. Other problems are the relation of tsetse to game reserves, cattle and bush-fire policy. Burning may be light (as occurs when it is carried out very early in the dry season or after the rains have started) or fierce (when carried out as late as possible before the rains). Light fires allow the woodland to thicken, whereas fierce fires tend to keep it open and therefore discourage tsetse. However, they damage the grass cover and leave the soil unprotected from the early rains, and the needs of soil conservation probably outweigh tsetse control in importance everywhere except in the *G. brevipalpis* area north of Karonga.

Norris (K. R.). **A Method of marking Calliphoridae (Diptera) during Emergence from the Puparium.**—*Nature* **180** no. 4593 p. 1002, 2 refs. London, 1957.

If adult Diptera marked and released for subsequent recapture in ecological studies are intended to simulate naturally emerging flies added to the wild population, it is desirable to avoid the preliminary period of captivity that most marking methods involve. This can be done by rearing the larvae in a radioactive medium [*cf. R.A.E.*, B **39** 181], but a method that has been used for studies with *Lucilia cuprina* (Wied.) in Australia is to allow the flies to emerge naturally from puparia covered by an inch of fine, dry sand mixed with 0·5 per cent. of a fluorescent dust. They retain some of the dust on the ptilinal suture and frontalia, where it is held on minute scales that become crowded together as the ptilinum is retracted, and they may readily be identified by means of it under ultraviolet light. The exit of the flies from the culture vessels should be facilitated, as the film of dust on the pulvilli temporarily reduces their ability to climb on smooth surfaces. Surplus dust usually disappears from their bodies in about a day, but if any is transferred to unmarked flies in traps, these may be distinguished from liberated ones by their lack of the characteristically vivid frontal pattern. Many marked flies may be detected during exposure of whole catches to ultraviolet light, but for critical examination, the flies must face the source of radiation. Only three of the many fluorescent dusts tested proved entirely satisfactory. They had irregular particles, mostly less than 2μ in diameter, and cohesive qualities that made them cake together, whereas unsatisfactory dusts could be poured freely and had larger, rounded particles. Marked flies were similar to untreated ones in length of life, fertility and behaviour. One

marked female was recaptured four weeks, and one marked male six weeks, after emergence in the field. Two species of *Calliphora* and *Chrysomyia rufifacies* (Macq.) were also marked satisfactorily, in limited tests, and the method is expected to prove applicable to other Calliphorids.

WRIGHT (F. N.). **Rearing of *Simulium damnosum* Theobald (Diptera, Simuliidae) in the Laboratory.**—*Nature* **180** no. 4594 p. 1059, 5 refs. London, 1957.

In view of the importance of *Simulium damnosum* Theo. as the main vector of onchocercosis [caused by *Onchocerca volvulus*] in Ghana [*cf. R.A.E.*, B **45** 191] and elsewhere, and the fact that it has apparently not hitherto been reared from the egg, a description is given of an apparatus and method by which this was done. A trough of corrugated asbestos roofing material was inclined at an angle of 20° in an aquarium tank containing 3 gal. river water, which was circulated through the trough by a pump delivering about 60 gal. per hour at an estimated velocity of 3·8 ft. per sec. Aeration was provided by keeping the water level 2 in. below the lower end of the trough to form a miniature waterfall and by piercing the polythene outflow pipe 1 ft. from the outlet with a suitably inclined transfusion needle so that a stream of air was drawn in. A mass of some 10,000 eggs laid on submerged grasses was obtained from the River Volta at 9 a.m. on a day in June, and three hours later, when some were already hatching, the grasses were placed in the trough and the water circulated. The eggs continued to hatch during the day, the hatching time comparing favourably with the 36 hours already noted [**45** 192]. As the larvae grew, the water became clearer owing to the filtering out of plankton and suspended matter. At increasingly frequent intervals, ½ gal. water was removed and replaced by river water in which the suspended matter had been concentrated about 500 times by filtering through a fine plankton net. After seven days, many of the larger larvae migrated up to 15 in. into the outflow pipe, possibly to take advantage of increased current velocity or greater depth of water. Eight pupae were formed, all in the outflow pipe, 14–17 days after hatching [*cf.* **45** 192], and after a pupal stage of 2–3 days, seven adults emerged into a cage over the apparatus. Four escaped, and only three males were collected. On the nineteenth day, all the remaining larvae were found to be detached and dead. The pH of the water in the tank was 7·3, as compared with 6·9 for fresh river water, and the temperature averaged 25·8°C. [78·44°F.]. The death of the colony is attributed to the accumulation of excreta in the tank.

In a further experiment, in which the water was changed every two days, the minimum length of the cycle from egg to adult was 16 days for males and 20 for females and the duration of the larval stage varied from 14 to 40 days.

BAR-ZEEV ([formerly] WOLFINSOHN) (M.). **The Effect of Density on the Larvae of a Mosquito and its Influence on Fecundity.**—*Bull. Res. Coun. Israel* (B) **6** no. 3–4 pp. 220–228, 1 graph, 12 refs. Jerusalem, 1957.

Experiments were carried out in Israel with a local strain of *Aëdes aegypti* (L.) to determine why crowding is detrimental to the larvae [*cf. R.A.E.*, B **23** 71] and what effect larval crowding has on the adults. In a preliminary test, two series of five groups of 30 newly hatched larvae were introduced into 100 ml. tap water in 250-ml. flasks, and 0·1, 0·2, 0·6, 1 or 1·4 g. baker's yeast was added in two equal parts at an interval of three days. In one

series, 100 units of penicillin and 20 μg. chloromycetin per ml. were added every two days to each container, to prevent the development of bacteria and so keep the food supply unchanged. Above 0·6 g. yeast, the amount of food had no effect on the growth rate of the larvae, and the antibiotics delayed development but had no effect on mortality. When the amount of food was smaller the growth rate was greatly reduced, and the presence of the antibiotics accelerated development. The culture without antibiotics contained $8{\cdot}6 \times 10^6$ bacteria per ml. and the one with antibiotics 2×10^2 per ml. or less, too few to contribute to the nutrition of the larvae.

When the number of larvae per 100 ml. was gradually increased and the amount of food per larva kept constant, there was delay in development but no undue mortality, provided that the amount of food was not so high that a film formed. In flasks in which a film and an overgrowth of moulds formed on the water surface, larvae and pupae died, probably through interference with respiration. When the larvae were transferred every second day to fresh water with yeast and antibiotics, crowding affected neither growth rate nor mortality and therefore had no mechanical effect on the larvae. To determine the effect of accumulating metabolites, two groups of 30 newly hatched larvae were reared in the filtrate from 100 ml. tap water in which about 2,000 larvae had been reared for 12 days with the daily addition of small amounts of yeast; 0·6 g. yeast was supplied as food. They showed the same rate of growth and mortality as two similar groups introduced into ordinary tap water. Similarly, there was no difference in an experiment to determine the effect of any possible unstable metabolites, in which about 100 larvae were transferred daily to water prepared in the same way immediately beforehand.

When groups of 30 newly hatched larvae were reared on a normal amount of yeast (0·6 g. in two portions) and similar groups on a very small amount (20 mg. every 4–5 days), the resulting females were found, 48 hours after a blood-meal, to contain averages of 111·2 and 57·7 eggs, respectively, the difference being highly significant. The average weights of females reared under the two sets of conditions were 2·4 and 1·3 mg. and the amounts of blood ingested by them were 2 and 0·8 mg., both differences again being highly significant.

Lewallen (L. L.). **Paper Chromatography Studies of the** *Anopheles maculipennis* **Complex in California (Diptera: Culicidae).**—*Ann. ent. Soc. Amer.* **50** no. 6 pp. 602–606, 6 refs. Washington, D. C., 1957.

The following is virtually the author's summary. The adult characters of mosquitos of the complex of *Anopheles maculipennis* Mg. in California have not been entirely satisfactory in distinguishing some populations of *Anopheles occidentalis* D. & K. from *A. freeborni* Aitken. *A. occidentalis* is typically a coastal species with a coppery to silvery mark at the wing apex in populations from Pismo Beach northward, while populations from Pismo Beach southward often lack the wing mark or have an indistinct one, thus resembling *A. freeborni*. Procedures for collecting and rearing these two species in the laboratory and methods of preparing chromatograms for comparison are discussed. Comparisons of fresh-tissue, one-dimensional, ascending chromatograms revealed that the ninhydrin-positive patterns formed by protein constituents from the northern and southern populations of *A. occidentalis* showed closer affinity to one another than either did to the *freeborni* pattern. The northern *occidentalis* chromatograms contained four or five ninhydrin-positive spots; the southern *occidentalis* contained three to five spots, while the *freeborni* chromatograms contained seven or eight spots. A difference in pattern was noted between male and female populations from

the same locality, in most instances, as well as differences between sample populations of the same species from different areas. These differences did not affect the overall pattern for comparison of the two species. The preliminary results indicate that paper chromatography shows promise as another means of distinguishing between populations of *A. occidentalis* and *A. freeborni.*

MENZIES (G. C.). **The Cattle Ear Mite,** *Raillietia auris* **(Leidy, 1872) in Texas.**—*J. Parasit.* **43** no. 2 p. 200. Lancaster, Pa., 1957.

A cow at an abattoir in Texas was seen in January 1952 to be holding its head to one side and rubbing its ear against a fence. No cause was found when the outer ears were examined, but three females, one male and a nymph of *Raillietia auris* (Leidy) were recovered when the bulla tympanica was opened. Heads of other cattle slaughtered at the abattoir were examined, and 43 mites of the same species were found in four more cows. These findings suggest that *R. auris* may be more prevalent in the United States than has been supposed, since it probably escapes detection during standard slaughterhouse inspections.

MCLINTOCK (J.) & DEPNER (K. R.). **Preliminary Attempts to establish a Laboratory Colony of the Horn Fly,** *Siphona irritans* **(L.) (Diptera: Muscidae).**—*J. Parasit.* **43** no. 2 pp. 209–212, 14 refs. Lancaster, Pa., 1957.

Adults of *Siphona irritans* (L.) were confined in cages of various types and fed on defibrinated or citrated beef blood in an attempt in Alberta to establish a laboratory colony, but the oocytes did not complete development and mating did not take place. Attempts were therefore made to induce ovarian development and egg-laying by allowing the flies to feed on their normal host. At first, they were confined for feeding in lantern-chimney cages strapped to the back of the host. This was satisfactory on a calf, but the chimneys could not be kept in place on a cow and most of the flies were lost. In other tests, the flies were confined continuously on the host in a wire-screen cage measuring 3 × 3 × 2 in. However, this caused injury if glued to a clipped area on the back. It was satisfactory on a cow when attached with straps, but a young calf was too active and many flies escaped.

The oocytes attained about half their full development when the flies were fed twice daily in chimneys on a calf. Oocytes developed fully when flies were fed twice daily on a cow, and two out of three females laid eggs. Flies kept on the back of a calf in cages survived up to six days, and on a cow at least eight days. In the case of the calf, eggs were laid by one out of 14 females examined, only partial development of the oocytes occurred in the remainder, and no evidence of mating was found. When the flies were confined on a cow, 16 out of 29 females examined were found to have laid eggs and nine had mated. Egg-laying did not begin before the fifth day of confinement on the host. Cow's blood and calf's blood apparently differ in nutritional value for *S. irritans*, and the physical environment provided by a calf seems to be less suitable than that provided by a cow. A colony of *S. irritans* could probably be maintained on a cow in a screened stall, but this would allow little control over the colony. If the flies are confined on the back of the host for the period of ovarian development, timing is critical as the females tend to oviposit on the cow when eggs mature, and the latter are difficult to find among the hair.

Moule (G. R.), McFarlane (B. D.), Young (R. B.) & Derbyshire (D. S.). **Field Observations on Aldrin, Dieldrin, Diazinon and Arsenic in the Prevention and Control of Breech Strike in Merino Sheep.**—*Aust. vet. J.* **33** no. 1 pp. 15–20, 2 refs. Sydney, 1957.

Arsenic was the only insecticide used for jetting to prevent blowfly strike in sheep in Australia until about 1950, and though chlorinated hydrocarbons [*cf. R.A.E.*, B **46** 55, etc.] have recently been extensively used, arsenical preparations remain the cheapest jetting fluids. They are, however, too toxic for application to the wool over large strikes, whereas chlorinated hydrocarbons and organic phosphates are unlikely to have adverse effects when so used, and BHC has been jetted into the wool of struck sheep for some years [*cf.* **41** 65]. Trials were carried out in Queensland in August–November 1955 and February–April 1956 to compare the protection afforded by aldrin, dieldrin and diazinon [O,O-diethyl O-2-isopropyl-4-methyl-6-pyrimidinyl phosphorothioate] with that by arsenic and to assess the control of existing strikes effected by aldrin, dieldrin, diazinon and BHC.

Over 200 comparatively plain-breeched Merino ewe lambs 3–5 months old that had not been shorn, crutched or subjected to Mules' operation [**32** 142] were used in each year. They were classified as plain-breeched or wrinkly-breeched and divided at random into groups. In 1955, four groups were jetted in August with ½ gal. 0·04 per cent. diazinon, 0·05 per cent. aldrin, 0·05 per cent. dieldrin or 0·8 per cent. arsenic trioxide as sodium arsenite, and a fifth left untreated. The fluid was applied at a pressure of 60 lb. per sq. in. through a three-jet nozzle, down the back line for about 4 in. on either side of the spine from head to tail, over the breech and in the crutch, and the wool was wetted to the skin. The sheep were examined weekly for 13 weeks, and the numbers of eggs and larvae present recorded. If a strike was extensive or larvae had survived in treated wool, the wool on and around the strikes on sheep originally treated with diazinon, aldrin or dieldrin was dressed with the same insecticide, and that on sheep treated with arsenic was dressed with 0·05 per cent. BHC. Untreated sheep were similarly dressed with BHC as soon as larvae were detected. In 1956, three groups were jetted in February with ½ gal. 0·04 per cent. diazinon, 0·05 per cent. dieldrin or 0·8 per cent. arsenic trioxide as sodium arsenite, respectively, one group was tip sprayed with 20 oz. 0·05 per cent. dieldrin per animal, and one was left untreated. In tip spraying, the tip of the wool over the withers, back and breech was wetted with a fine spray from seven nozzles on a U-shaped boom substituted for the multi-jet hand piece on the jetting plant. The animals were examined weekly for two months, and eggs and larvae were recorded and struck sheep retreated as before.

No body strike occurred, but breech strike was common enough for comparison of treatments. Jetting with diazinon and dieldrin gave the best results. In 1955 and (in brackets) 1956, 27 (43) plain-breeched lambs were jetted with diazinon and 27 (43) with dieldrin, and blowflies oviposited on 2 (3) and 1 (1) and larvae developed on 1 (2) and 1 (0), respectively; 23 (4) wrinkly-breeched lambs were jetted with diazinon and 23 (4) with dieldrin, and eggs were laid on 9 (1) and 7 (1), and larvae developed on 5 (0) and 6 (1), respectively. Of 30 plain-breeched controls in 1955 (and 43 in 1956), eggs were laid on 7 (7) and larvae developed on 5 (7), and out of 20 wrinkly-breeched controls in 1955 (and 5 in 1956), eggs were laid on 6 (4) and larvae developed on 4 (4). Diazinon gave complete protection and dieldrin good protection for four weeks. Jetting with aldrin or arsenic and tip spraying with dieldrin were not very satisfactory in preventing strike from developing. Although the numbers of sheep concerned were small, the results suggested that aldrin, diazinon, dieldrin and BHC at the strengths used were unlikely to give complete protection against early re-strike.

Kerr (R. W.), Venables (D. G.), Roulston (W. J.) & Schnitzerling (H. J.). **Specific DDT-resistance in Houseflies.**—*Nature* **180** no. 4595 pp. 1132–1133, 7 refs. London, 1957.

A strain (D) of house-flies (*Musca domestica* L.) was derived by selection from a DDT-susceptible colony by incorporating DDT as a wettable powder in the larval medium at 80 parts per million for the first three generations, 160 p.p.m. for the next six and 320 p.p.m. for subsequent generations. A second strain (L) was established ten generations later than D and selected by breeding only from flies emerging towards the end of the emergence period, since DDT-resistance has been shown to be associated with a prolonged larval period [*R.A.E.*, B **39** 182]. The breeding stock of strain L was not exposed to insecticides. Periodically, 40 males and 40 females of each selected strain and the unselected parent strain (U) were treated with DDT in kerosene solutions of various strengths, with an auxiliary solvent if necessary, applied topically to the thorax at about 0·08 μl. for males and 0·13 μl. for females. Treated flies were supplied with 10 per cent. sugar solution and kept at 25°C. [77°F.] for mortality counts 24 hours after treatment. Both selected strains developed resistance to DDT. It increased rapidly during the first four generations, and then showed no further major change for 30 generations, during which the LD50's of the D and L strains were about 15 and 11 times, respectively, that of strain U. Strains D and U did not differ significantly over 30 generations in the duration of the period from oviposition to maximum daily adult emergence, but selection over 16 generations retarded pre-adult development in strain L by a significant mean of 1·6 days as compared with U. No evidence was found in strain D of increased resistance to insecticides of the BHC group [*cf.* **44** 111] when γ BHC was applied topically, or to sodium arsenite given orally in sugar solution. Strain L was non-resistant to γ BHC, allethrin, diazinon [O,O-diethyl O-2-isopropyl-4-methyl-6-pyrimidinyl phosphorothioate] and sodium arsenite [*cf.* **43** 190]. The toxicity of DDT to the resistant strains was increased considerably by the synergistic action of DMC [di(p-chlorophenyl)-methylcarbinol]. Thus, a similar type of specific DDT-resistance appeared to have developed in both selected strains. Since DMC inhibits the dehydrochlorination of DDT by resistant flies [**43** 28], the three strains were examined for the presence of DDT-dehydrochlorinase. L flies of the 18th generation and D flies from a special culture of the 28th generation in medium containing no DDT were used. Extracts prepared from batches of 40 flies were incubated with 400 μg. DDT by a technique described, and the amounts of unchanged and dehydrochlorinated DDT determined. The amounts of DDT recovered (in μg.) from U, L and D males and (in brackets) females were 364 (382), 308 (327) and 298 (313) and the corresponding amounts dehydrochlorinated were 0 (6), 82 (64) and 67 (51). The LD50's (in μg. per g. flies) of DDT for males and (in brackets) females of these three groups of flies and of D flies reared in medium containing DDT were 4·9 (6·6), 46 (86), 41 (85) and 77 (155). The fact that males of both the L and D strains were less resistant but showed higher enzyme activities than females is unexplained. Since the selected strains developed similar enzyme activity and DDT-resistance although selected by different methods, enzymatic dehydrochlorination of DDT seems likely to have been the major factor in resistance. The occurrence of DDT-dehydrochlorinase and specific resistance to DDT in strain L showed that production of the enzyme does not depend on a stimulus from DDT and precludes any possibility that this type of resistance is due to a mutagenic action of DDT. The function of the enzyme in L flies is not known. The fact that on two occasions, ten generations apart, resistance began to develop immediately selection was begun suggests that the parent colony contained a self-propagating small proportion of

abnormally DDT-resistant individuals already possessing the enzyme, and that this proportion was increased by selection, either with DDT or for slow pre-adult development, until it constituted a majority in the resistant strains. If a functional relation exists between DDT-resistance, due to possession of the enzyme, and rate of pre-adult development, it is obscure, since D flies showed no sign of retarded development.

MASTBAUM (O.). **Malaria Control in Swaziland. Some Observations during the first Year of partial Discontinuation of Insecticides.**—*J. trop. Med. Hyg.* **60** no. 8 pp. 190–192, 1 map, 2 refs. London, 1957.

In view of the interruption of malaria transmission in Swaziland and the fact that the overall parasite rate in children was well under 1 per cent. in 1956, hut spraying with wettable BHC, which had much reduced numbers of *Anopheles gambiae* Giles and apparently eradicated *A. funestus* Giles [*R.A.E.*, B **46** 68], was discontinued in the middle veldt and bush veldt in 1957. However, all huts in a band about 15 miles wide along the northern, eastern and southern borders, including the sites of two irrigation schemes, received two applications. In an examination of 5,427 random samples of blood, the parasite rates in children less than 1, 1–5 and 6–16 years old were 0, 0·4 and 0 per cent. in areas in which control measures had ceased, 0·14, 0·43 and 0·28 per cent. in sprayed areas along the eastern border and 0·66, 2·39 and 3·9 per cent. in irrigation areas. Some of the cases in the irrigation and other sprayed areas may have been contracted outside Swaziland. Larvae of *A. gambiae* were much more numerous in untreated areas than they had been in years when spraying was in force or than they were in the areas still being sprayed, and adults reappeared in huts in the untreated areas, though never at a rate of more than 1 per ten huts. A few larvae of *A. funestus* were seen in one small district in the bush veldt, but no adults were found in dwellings. It remains to be seen whether the numbers of *A. gambiae* inside huts will eventually increase to pre-control level and if so whether malaria transmission can be kept at zero. No operational changes were contemplated for 1958. In one sprayed bush-veldt area, a few adults of *Phlebotomus freetownensis* Sinton were found in huts, which may indicate the development of resistance to BHC in this species.

VOGE (M.) & HEYNEMAN (D.). **Development of *Hymenolepis nana* and *Hymenolepis diminuta* (Cestoda: Hymenolepididae) in the intermediate Host *Tribolium confusum*.**—*Univ. Calif. Publ. Zoöl.* **59** no. 9 pp. [3 +] 549–579, 8 pls., 1 graph, 19 refs. Berkeley, Cal., 1957.

Detailed comparative accounts are given of the larval development of *Hymenolepis diminuta* and *H. nana* in adults of the Tenebrionid, *Tribolium confusum* Duv., maintained at 30°C. [86°F.]. Five stages in the growth of the larvae are distinguished, and the average times taken for development were 180 hours for *H. diminuta* and 132 hours for *H. nana*. The beetles were infected by feeding on eggs of the tapeworms, after starvation for 5–14 days. A heavy infection usually gave 10–15 cysticercoids per beetle for *H. diminuta* and 35–45 for *H. nana*, with maxima of 55 and 75, respectively. Variability observed in the growth rate of *H. nana* and in the morphology of *H. diminuta* is discussed and attributed to crowding in the beetle. In neither case was there evidence that viability or scolex size was affected.

BURCHAM (E.). **Artificial Insemination of *Aedes aegypti* (L.).**—*Canad. Ent.* **89** no. 11 pp. 494–495, 5 refs. Ottawa, 1957.

Artificial insemination of insects would make it possible to initiate and maintain colonies of species that do not mate under laboratory conditions.

and a method is described by which it was achieved with *Aëdes aegypti* (L.). Males separated from females 24–36 hours after emergence, and unmated females, reared from selected pupae, were kept for 9–14 and 7–12 days, respectively, and supplied with 10 per cent. sugar solution. A pipette was constructed by fitting a pyrex capillary tube over a 23-gauge hypodermic needle cut a quarter of an inch from the hub, to which the tube was cemented with sealing wax; the other end of the tube was drawn out to an outside diameter of 45–75 μ. The accessory glands of the male, which, with the seminal vesicle, had been transferred to a drop of physiological saline, were crushed, part of the extruded granular material was aspirated into the pipette, and, without removal of the latter from the saline, the seminal receptacle was ruptured and as much sperm as possible drawn into the pipette. This was immediately transferred to the vulva of a female that had been anaesthetised by exposure to carbon dioxide for a minute and fixed on its back in a holding block under a microscope. The tip of the pipette was placed between the atrial plates of the ninth sternite (the dorsal tip of the vulva), which had been exposed by pulling the cerci back with tweezers; the contents of the pipette were then forced into the bursa copulatrix until the eighth abdominal segment expanded slightly, when the process was stopped to avoid rupture of the bursa. Females were fed on mouse blood either 48 hours before insemination or 24 hours after it. In all, 175 females were inseminated, 84 survived to oviposit, and 15 of these laid one or more fertile eggs. Of 1,129 eggs laid, 181 were fertile. The highest percentage of fertile eggs laid by one female was 70. None of the control groups produced fertile eggs, whether the females were untreated, had been anaesthetised for 31 minutes or had received injections of accessory gland in saline or of saline alone. The descendants of several inseminated females were reared through two generations with apparently normal mating and oviposition. The method does not achieve a natural level of insemination, but, in a preliminary test, a substantial reduction in the mortality of the females and an increase in successful inseminations resulted from the addition of terramycin at 0·1 mg. per 100 ml. saline.

Wright (R. H.). **A Theory of Olfaction and of the Action of Mosquito Repellents.**—*Canad. Ent.* **89** no. 11 pp. 518–528, 6 figs., 15 refs. Ottawa, 1957.

To produce an odour sensation, a substance must be volatile and its molecules must come into contact with the olfactory end organ of the receiving organism. There is evidence that the physical basis of odour is low-frequency molecular vibration [*R.A.E.*, B **45** 52], and a mechanism whereby such vibrations might be able to initiate discharges of the olfactory nerve is here discussed. It requires that the possession of an odour by a particular substance will depend on its having the necessary volatility together with a certain low-frequency mode or modes of molecular vibration, that the type of odour will depend on the particular frequency or combination of frequencies of the vibrational modes, and that the odour threshold concentration (minimum amount of material required to produce an odour sensation) will depend on the closeness of the coupling between the odorous molecules and pigment molecules in the olfactory end organ and on the closeness of the match between their natural frequencies of vibration.

The infra-red absorption curves in the range 700–400 cm.$^{-1}$ for 25 substances believed to be true olfactory repellents for mosquitos, 18 additional repellents whose mode of action is doubtful and 28 non-repellents are shown in figures. A striking correlation is demonstrated between repellency and a vibrational mode near 460 cm.$^{-1}$ [*cf. loc. cit.*]. The effects of water vapour, which is

commonly regarded as an attractant for mosquitos but has a well-defined infra-red absorption maximum at 457 cm.$^{-1}$, are discussed, and evidence is cited from the literature to show that it becomes repellent to *Aëdes aegypti* (L.) at a sufficiently high concentration [*cf.* **39** 189]. If mosquito-repellent substances are adsorbed much more strongly on to the surface of the end organ than molecules of water, a small concentration of a repellent substance could be expected to produce a similar response to a very large concentration of water-vapour molecules, and repellent substances would owe their action to their ability to produce an illusion of high humidity and so evoke the avoiding reaction that high humidities produce.

Jones (J. C.). **A new Standard for the rapid Detection of DDT Tolerance in *Anopheles quadrimaculatus* Larvae and Pupae.**—*Mosq. News* **17** no. 1 pp. 1–9, 2 refs. Albany, N. Y., 1957.

A simple exposure test for rapidly and accurately measuring the DDT tolerance of larvae and pupae of *Anopheles quadrimaculatus* Say of known sexes and ages is described, and it is shown to give comparable results when applied to randomly selected fourth-instar larvae reared under uniform conditions. This test has the advantage of permitting as many as six laboratory and at least four field determinations of resistance on the same population and may thus have considerable value in practical field testing for tolerance. The test consisted in rinsing the larvae and pupae in distilled water, putting them individually for 1–360 minutes according to age in 30 ml. glass beakers containing 10 ml. distilled water with 100 parts per million DDT in suspension from acetone solution (freshly prepared for each test), re-rinsing them and maintaining them in 50 ml. glass beakers with food and water. The condition of the larvae and pupae was checked after two hours, and daily thereafter until they died, pupated or emerged, and a median lethal exposure time was determined. The test was applied to a strain that had been reared in the laboratory for about 10 years, mainly under unstandardised conditions, and that had never knowingly been exposed to DDT or any other toxicant. Preliminary results showed that about 87 per cent. of larvae that survived exposure for 24 hours gave rise to adults, and an accurate measure of adult survival could be calculated from the 24-hour readings alone. The test was applied to third- and fourth-instar larvae of known sex [*R.A.E.*, B **46** 133], and pupae, sexed by examination of their external genitalia. The median lethal times of exposure for male and (in brackets) female third-instar larvae of unknown age, and fourth-instar larvae exposed at ages of 1, 24, 48 and 70 hours, based on examination after 24 hours, were 14 (16), 4·5 (5), 19·5 (21), 27·5 (36) and 42 (48) minutes, respectively, and of pupae at ages of 1 and 24 hours, based on adult emergence, 76 (87) and 184 (220) minutes, respectively. Application of this test to fourth-instar larvae, reared under uniform conditions, that had been randomly selected and whose ages were only known to about a day, gave results that matched reasonably well with those just described; tests on such larvae indicated that neither feeding nor overcrowding during exposure significantly altered the results, but that starvation of newly moulted individuals for 24 hours reduced their tolerance to that of hour-old fourth-instar larvae.

Love (G. J.) & Smith (W. W.). **Preliminary Observations on the Relation of Light Trap Collections to mechanical Sweep Net Collections in sampling Mosquito Populations.**—*Mosq. News* **17** no. 1 pp. 9–14, 3 figs., 1 ref. Albany, N. Y., 1957.

Frequently, no allowance is made in analyses of light-trap catches of mosquitos for differences in the degree to which various species are attracted

to light. In south-western Georgia, catches were made between April 1954 and December 1955 from a tower in a wooded area near a pond in which mosquitos bred; a vertical series of three New Jersey light-traps, with 25-watt frosted incandescent bulbs, were operated one night a week from 6 p.m. to 6 a.m., at heights of 6, 25 and 40 feet, and six pairs of mechanical sweep nets at heights of 3 and 50 feet from 6 p.m. to 9 a.m. on another night. Indices of the attractiveness of light-traps for 27 species of mosquitos are given; these were determined by dividing the numbers of mosquitos of each species taken in the traps by the numbers taken in the sweep nets in the 60 weeks, well distributed throughout the two breeding seasons, during which all traps operated successfully. The numbers of ten species are believed to have been large enough for the indices, which range from 0·24 to 7·67, to be statistically valid.

Edgar (S. A.) & Herndon (J. F.). **A rotary Insect-preference Trap.**—*Mosq. News* **17** no. 1 pp. 14–17, 2 figs., 4 refs. Albany, N. Y., 1957.

A description is given of a hexagonal six-compartment electrically-operated rotary trap for determining the preferences of mosquitos or other blood-sucking flying insects for host, colour, light intensity and other factors. It is mounted on a tripod base, can be rotated at several speeds and is designed to eliminate the bias of position inherent in individual stationary traps or single-direction traps with several compartments. It can be operated in the field or in a room in which specific insects can be liberated.

McKiel (J. A.). **A simplified Method for large-scale laboratory Rearing of *Aedes aegypti* (L.).**—*Mosq. News* **17** no. 1 pp. 25–29, 2 figs., 3 refs. Albany, N. Y., 1957.

An apparatus is described in which large numbers of *Aëdes aegypti* (L.) were reared with little effort or attention. It consists of a removable cage (30 × 20 × 20 in.) mounted on top of a thermoregulated galvanised iron tank, 30 in. long and 14 in. wide at the bottom and 36 in. high. The top of the tank is tapered to an opening 6 in. square through which the adults pass into the cage, the opening normally being surmounted by an inverted funnel. The room is maintained at 26–28°C. [78·8–82·4°F.] and the water in the tank at 28°C. Food (dry biscuits and yeast) and newly hatched larvae are introduced through a funnel, and a tap is provided for drainage. Aeration is used to inhibit film formation on the surface of the medium. Adult emergence is practically complete in 16 days, and the collecting cage is replaced by an empty one when necessary. One of these units was used continuously for eight months with no signs of accumulating toxic products in the medium. About 40,000 larvae (four per ml. water) can be reared at one time.

Fletcher jr. (O. K.) & Flanagan (L.). **Winter Breeding of *Culex quinquefasciatus* Say in Columbus, Georgia.**—*Mosq. News* **17** no. 1 pp. 29–32, 7 refs. Albany, N. Y., 1957.

Culex pipiens fatigans Wied. (*quinquefasciatus*, auct.) was found in Columbus, Georgia, to breed and bite in every month from October 1955 to March 1956, inclusive. The weather was cold and dry up to the end of January, and breeding was up to then largely restricted to the numerous street catch basins of the combination storm and sanitary sewers, and surface

drains, from which viable eggs, larvae and adults were collected in every month; the adults, which favoured the interior walls of the basins, included males. Several egg rafts were collected after periods of 5 and 9 days during which the daily minimum temperature was near or below freezing point. Daytime water temperatures in the catch basins did not fall below 52°F. Rain flushed the basins so effectively in early February that breeding was terminated, but eggs and larvae appeared about a week later in water-holding domestic rubbish, which affords less permanent supplementary breeding sites. In other urban areas of Georgia, egg rafts, numerous larvae and pupae were collected from sewage-polluted streams in January and adults were numerous near them. Biting caused so many complaints that larvicide was applied to the catch basins in Columbus in December and throughout the winter in another town.

HAYES (R. O.) & MORLAN (H. B.). **Notes on *Aedes triseriatus* Egg Incubation and Colonization.**—*Mosq. News* **17** no. 1 pp. 33–36, 6 refs. Albany, N. Y., 1957.

The technique described by Repass [*R.A.E.*, B **41** 106] for establishing laboratory colonies of *Aëdes triseriatus* (Say) greatly enhanced the usefulness of the species in research. As low percentage hatch has often jeopardised the existence of established colonies, however, a study was made of the requirements for egg development and hatching. A self-maintaining colony was established in cubic, wood and screen cages with sides 22 in. long, from larvae collected in Georgia. Temperature was maintained at about 75°F. and relative humidity at about 75 per cent., and a rabbit was provided as a source of blood for three hours every day. From September to January, an automatically operated light system furnished a 45-minute evening crepuscular period followed by 10 hours of darkness. Handling and storage of eggs was facilitated by providing for oviposition, instead of wooden blocks, 600 ml. beakers, each lined with a strip of paper towelling 3 in. wide and containing about 200 ml. water.

To determine the time needed for development, eggs of known ages were tested at about 79°F.; batches were removed from the beakers at daily intervals from the third to the eighth day and immersed in tap water. The percentage hatch was determined after 24 hours, and unhatched eggs were placed on adhesive tape and dissected. The results showed that a minimum of four days was necessary for complete development of the embryo, and of six days for hatching of all the eggs in a batch. Other tests showed that percentage hatch was increased by immersing eggs in a day-old mixture of 0·1 g. each of ground dog food and powdered brewers' yeast in a litre of water, instead of in fresh tap water.

Samples of about 100 eggs, six and eight days old, were obtained that had been incubated at a temperature of about 79°F. in a saturated atmosphere (on moist paper towelling in a closed oviposition beaker) or at 70, 80 and 90 per cent. relative humidity for the whole of the time or in a saturated atmosphere for part of it followed by periods decreasing by daily intervals at 70, 80 or 90 per cent. humidity; the percentage hatches of these samples, based on egg and larval counts, was determined by immersing the eggs for 22 hours in equal quantities of the standard hatching medium. The percentage hatches of the eggs of both ages kept continuously at the various percentages of relative humidity never exceeded 30 but those kept continuously at saturation showed percentages two and a half times this figure or more. Eggs of both ages, incubated for a part of the time at 80 per cent. relative humidity, consistently hatched better than those incubated for similar periods of time at either 70 or 90 per cent. The best average hatching rate in eggs six days

old was 78 per cent., in those incubated continuously in a saturated atmosphere, and the best in eggs eight days old was 90 per cent., in those incubated for the first six days in a saturated atmosphere and the last two in 80 per cent. relative humidity.

Samples averaging about 100 eggs, kept at about 75°F., were taken at weekly intervals, and their hatching tested by immersion for four hours in equal quantities of the standard hatching solution; percentage hatch decreased from an average of 75 per cent. for eggs 1–2 weeks old to a little over 50 per cent. for those 3–8 weeks old and to only 33 per cent. for those 9–11 weeks old.

Downe (A. E. R.) & Morrison (P. E.). **Identification of Blood Meals of Blackflies (Diptera: Simuliidae) attacking Farm Animals.**—*Mosq. News* **17** no. 1 pp. 37–40, 11 refs. Albany, N. Y., 1957.

The food preferences of Simuliids were investigated on a farm in Quebec in the summer of 1954 by means of precipitin tests of extracts of 1,672 blood-engorged adults taken in window exit traps in a barn housing horses, cattle, pigs and fowls. The extracts were prepared either from fresh smears made immediately on capture or from dried, mounted specimens previously identified. Except for *Simulium rugglesi* Nicholson & Mickel, which is well-known as a bird feeder [*cf. R.A.E.*, B **45** 94], all the eight species studied had fed on horses or cattle, but only a few bit pigs or fowls, which were seldom attacked. The one individual of *S. rugglesi* identified had fed on a bird. Only 0·3 per cent. of the feeds were undetermined, so that there is little possibility of other hosts being involved, and only one specimen, unidentified, showed evidence of feeding on more than one host. Some limitations of host-preference studies of Simuliids are discussed.

Markos (B. G.) & Sherman (E. J.). **Additional Studies on the Distribution of Mosquito Larvae and Pupae within a Rice Field Check.**—*Mosq. News* **17** no. 1 pp. 40–43, 2 graphs, 3 refs. Albany, N. Y., 1957.

The studies described in this paper, which were carried out in 1949 in Butte County in the Sacramento Valley in northern California, the foremost rice-growing area in the State, followed the same lines as others made in Stanislaus County in the San Joaquin Valley in 1947, and the results were similar [*R.A.E.*, B **41** 204].

Russell (P. F.). **World-wide Malaria Distribution, Prevalence, and Control.**—*Amer. J. trop. Med. Hyg.* **5** (1956) no. 6 pp. 937–965, 36 refs. Baltimore, Md., 1957.

The distribution and importance of malaria throughout the world, based on data available in 1955, and the progress of control by that year are discussed. For each country, the total population, the population of malarious areas and the population protected by routine control measures are shown, and mention is made of the Anophelines responsible for transmission. It is concluded that eradication is technically and economically practicable for many countries within ten years, but that more effective measures for eradicating malaria among primitive and relatively inaccessible peoples and practical measures for dealing with the final phases of nation-wide eradication projects are needed. A clearer understanding of the prime causes and practical implications of Anopheline resistance to insecticides and a clarification of the position of *Anopheles gambiae* Giles in Africa as a species or a complex and determination of its behaviour characters in relation to malaria are desirable [*cf. R.A.E.*, B **46** 205].

Gabaldon (A.). **The Time required to reach Eradication in Relation to Malaria Constitution.**—*Amer. J. trop. Med. Hyg.* **5** (1956) no. 6 pp. 966–976, 12 refs. Baltimore, Md., 1957.

In Venezuela, malaria has been responsive in some areas and partly refractory in others to house-spraying with DDT for the control of the Anopheline vectors, depending on the habits of the latter. The disease has been eradicated from the former areas, as for example from the great north-central region, where indigenous cases have not been found since 1951 [*R.A.E.*, B **44** 27]. The time needed for eradication after the beginning of a spraying programme varied with the constitution of the malaria, that is, the degrees of endemicity and epidemicity of the disease peculiar to a given region. The north-central region included a group of localities (group I) in which endemicity was high and epidemicity low, a group (II) in which epidemicity was high and endemicity low and a group (III) in which both were low. Eradication was achieved by the fifth year in groups I and II, and no cases were observed after three years of spraying in group III.

The chief vectors were *Anopheles darlingi* Root and *A. albimanus* Wied., and the time needed for the eradication of malaria depended mainly on them. *A. albitarsis* Lynch Arrib. was present but was unimportant except in a limited district. *A. aquasalis* Curry in the north-central region lays eggs similar to those described from Panama [*cf.* **20** 93–94] but different from those of the malaria-carrying form present in eastern Venezuela, the West Indies and Brazil; it therefore probably played little part in transmission. *A. pseudopunctipennis* Theo. probably transmitted some malaria where it co-existed with the main vectors, but where it was alone only sporadic infections were found. *A. darlingi* was the main vector in localities of group I. In localities of group III, the densities of both *A. darlingi* and *A. albimanus*, when they were present, were very low. In localities of group II, where either or both were present, they showed irregular fluctuations in density, which were responsible for the epidemic outbreaks. Where *A. albimanus* alone was the vector, eradication was achieved in three years. It was never responsible for high endemicity and low epidemicity by itself, and as malaria of this epidemiological type is believed not to occur in Mexico, Central America or the Antilles, where *A. albimanus* is the chief vector, eradication of the disease there would probably not be difficult. The main obstacle to eradication in Venezuela as a whole has been the presence of partly refractory malaria transmitted by *A. aquasalis* and *A. nuñez-tovari* Gabaldon, and eradication may be difficult in countries in which the latter or the vector strain of the former occurs, as they often bite and rest out of doors; the same applies where *A. darlingi* sometimes does so.

Galindo (P.), de Rodaniche (E.) & Trapido (H.). **Experimental Transmission of Yellow Fever by Central American Species of *Haemagogus* and *Sabethes chloropterus*.**—*Amer. J. trop. Med. Hyg.* **5** (1956) no. 6 pp. 1022–1031, 13 refs. Baltimore, Md., 1957.

As a contribution to the study of possible vectors of jungle yellow fever in Central America, other than those known to transmit the disease in South America, transmission experiments were made with *Haemagogus equinus* Theo., which is widespread in Central America and occurs on both slopes [*cf. R.A.E.*, B **45** 34], *H. mesodentatus mesodentatus* Komp & Kumm, which occurs on the Atlantic slope from western Panama to south-eastern San Luis Potosi, Mexico, *H. m. gorgasi* Galindo & Trapido, which occurs on the Pacific side from Salvador to southern Sinaloa, Mexico, and *Sabethes chloropterus* (Humb.). South American *H. equinus* is known to be a

successful laboratory vector [**36** 114; **39** 71], but the part it plays in nature is in doubt. This species and *H. spegazzinii falco* Kumm, Osorno & Boshell [*cf.* **41** 26, etc.] were used as controls. A colony of *S. chloropterus* was established from Panama material. Mating was readily obtained in captivity, but feeding did not occur except when the whole monkey was caged with the mosquitos. A strain of yellow-fever virus recently isolated in Trinidad from the spleen of a howler monkey (*Alouatta*) [*cf.* **45** 101] was transmitted from monkey to monkey by bite in the one trial made with *H. m. mesodentatus* and in two trials each with *H. m. gorgasi* and *H. equinus*. In the trial with *H. m. mesodentatus*, a monkey bitten by only one female suffered a rapidly fatal infection. *H. s. falco* from Panama and *H. m. gorgasi* both failed to transmit a mouse-passaged strain of virus, which developed only very low titres in the blood of the source monkey [*cf.* **37** 228]. *H. equinus*, *H. m. mesodentatus* and *H. m. gorgasi*, as well as *H. regalis* D. & K. (*lucifer* (H., D. & K.)) from Panama and *H. s. falco*, were found by intracerebral mouse inoculation to harbour yellow-fever virus of one or other strain 1–4 weeks after the infective meal. The proportion doing so varied with the titre of virus in the meal. *S. chloropterus* transmitted the *Alouatta* strain of virus from monkey to monkey by bite in one of two trials, but the incubation period in the monkey receiving the infective bite was very long. No virus was isolated from mice inoculated with pools of this species.

Kartman (L.) & Prince (F. M.). **Studies on *Pasteurella pestis* in Fleas. V. The experimental Plague-vector Efficiency of wild Rodent Fleas compared with *Xenopsylla cheopis*, together with Observations on the Influence of Temperature.**—*Amer. J. trop. Med. Hyg.* **5** (1956) no. 6 pp. 1058–1070, 32 refs. Baltimore, Md., 1957.

The methods and system of numerical assessment used in the authors' work on the effectiveness as vectors of plague of various species of fleas that occur on wild rodents in the western United States and the influence of temperature on transmission by two species of fleas are the same as those described in an earlier paper of the series [*R.A.E.*, B **46** 162]. The criterion of plague-infection in the flea was confirmed culture of *Pasteurella pestis* from it after it had died or been killed. In the studies on the influence of temperature, which were made with *Xenopsylla cheopis* (Roths.) and *Diamanus montanus* (Baker), some of the fleas were kept at about 8°C. [46·6°F.] and some at about 30°C. [86°F.], but, in general, fleas were kept at room temperature (about 21°C. [69·8°F.]). For *X. cheopis* and *D. montanus*, data from the literature are summarised for comparison with the present results. The vector efficiency and (in brackets) vector index of *X. cheopis* at 21°C. were 0·48 (0·06). None of the 12 species from wild rodents that were compared with it approached it in vector efficiency, nor did *Leptopsylla segnis* (Schönh.) from the house mouse (*Mus musculus*). *Thrassis bacchi johnsoni* Hubbard and *Hystrichopsylla* sp. had the highest vector efficiencies (0·17 and 0·2, respectively) and approached *X. cheopis* in overall vector capacity as shown by their vector indices (0·01 and 0·02). *Hystrichopsylla* sp. has been found consistently infected in one area in which plague in wild rodents is enzootic and epizootic. Data obtained on the vector capacity of some species confirmed the findings of other workers. *D. montanus*, which was obtained from *Citellus* sp. or bred in the laboratory, was found to be a very poor vector under laboratory conditions, with a vector efficiency at room temperature of 0·04. The results, in conjunction with those of former workers, support the hypothesis that strain differences may account for the finding of both low and high vector capacity in fleas of this species from different places [*cf.* **41** 64].

Proventricular blocking did not occur in *D. montanus* at 8°C., although the infection potential was as high as it was at room temperature. The vector capacity of *X. cheopis* kept at 21°C. was near that found in other studies under similar conditions [*cf.* **30** 33; **46** 163]. Vector efficiencies were surprisingly high (0·81 and 1·15) at 8 and 20°C. [46·6 and 68°F.] and lowest (0·12) at 30°C. Corresponding vector indices were 0·09, 0·17 and 0·01. Comparison with published work showed a great variation in the vector indices at 20–22°C. [68–71·6°F.], for which it is difficult to account. Survival after blocking was poor in *X. cheopis* kept at 30°C., and this probably accounts for the very poor vector capacity at this temperature. A major effect of temperature was apparently its influence on the extrinsic incubation period in the flea. The average incubation period in *X. cheopis* was 34·4 days at 8°C., 18·6 days at 20–22°C. and 11·9 days at 30°C.

Bonnet (D. D.), Kessel (J. F.), Kerrest (J.) & Chapman (H.). **Mosquito Collections and Dissections for evaluating Transmission of Filariasis in Polynesia (Tahiti).**—*Amer. J. trop. Med. Hyg.* **5** (1956) no. 6 pp. 1093–1102, 16 refs. Baltimore, Md., 1957.

A description is given of an " intensive survey method " devised in Tahiti for the collection and dissection of females of *Aëdes polynesiensis* Marks for determination of the endemicity of infection with *Wuchereria bancrofti*, of which this mosquito is the most important local vector [*R.A.E.*, B **44** 62–63]. The method could be adapted to other species by modification of the collection procedure. Catches of biting females are made over a period of 10 minutes, in the shadiest and most protected sites available within 33 ft. of each habitation (dwelling, church, store, school, etc.) in the area under survey. One of a team of two men sits bared to the waist, while the other catches the mosquitos that alight on him, using an aspirator and plastic tube. The full period is spent at each station, even though the presence of mosquitos seems unlikely. Sites are not visited in sequence, but at random. Mosquitos are identified on capture, and all those from one station are put, with a strip of damp paper towelling, in a tube, which is labelled with the number of mosquitos, species and site of capture. Time and place of collection, weather conditions, numbers and species present are all recorded, and, from the assembled data, the number of females caught per minute of capture time, the percentage of habitations at which mosquitos are found and the percentage at which ten or more are caught are calculated. The method of collection averages the effect of the various factors that determine the numbers of females biting at any one time.

Ten mosquitos from each station, or the whole catch if less than ten, are dissected at a field centre under light anaesthesia, usually within 3–6 hours of collection. Legs and wings are removed, the head, thorax and abdomen are placed in separate drops of saline on a slide, and the thorax is divided into about three pieces. After about 30 minutes, many filariae will have separated themselves from the mosquito tissue, which is then teased apart, and the number of developing larvae, their species and their situation within the body of the mosquito are recorded. Records are compiled of the percentage of mosquitos infected either with all developing stages of *W. bancrofti* or with infective stages, the number of larvae per dissected mosquito and the percentage of stations at which infected mosquitos were caught.

During 64 intensive surveys made with this technique in 1953–55, the mosquito capture rate averaged 0·35 per minute, with a fall from 0·42 to 0·2 over the period. This fall is believed to reflect the effect of education in sanitation and the elimination of breeding sites [*cf.* **42** 90]. Mosquitos were

taken at 46 per cent. of the sites visited, and ten or more were caught at 10 per cent. of the sites. The product of the average number of larvae of *W. bancrofti* in the dissected mosquitos and the rate of mosquito capture per minute has been found to provide a satisfactory index of the progress of a filarial control programme.

HEWLETT (P. S.). **Interpretation of Dosage-Mortality Data for DDT-resistant Houseflies.**—*Ann. appl. Biol.* **46** no. 1 pp. 37–46, 2 figs., 23 refs. London, 1958.

The slopes of the lines relating probit-mortality to the log.-dose of DDT are generally lower for resistant than for susceptible strains of house-flies (*Musca domestica* L.). This indicates that flies of resistant strains are more heterogeneous in their reaction to DDT than those of susceptible strains [*cf. R.A.E.*, B **45** 27], although the selection involved in the production of resistance might have been expected to make the flies more uniform. Two factors that could each account for the phenomenon are discussed. The first concerns the relation of the amount of DDT absorbed to the dose applied. If resistant and susceptible strains of flies differ greatly in resistance, higher doses have to be given to the resistant flies to determine dosage-mortality curves. The slope of the curve depends both on the relation between probit-mortality and the amount of DDT absorbed, and that between the latter and the dose. The last may differ according to the strain, but this difference is not clearly correlated with resistance, nor do the rates of absorption show large enough differences to account for those observed in resistance. Attention is therefore directed to the effect of the dose range. If the amount of DDT absorbed could be measured at a time when the values obtained were fully relevant to the lethal action, not before sufficient has been absorbed to ensure some mortality or after completion of the physiological events ensuring death, the influence of the dose range on the slope of the curve could be elucidated. It is, however, possible that the period of absorption relevant to the lethal action varies so much from one individual fly to another that determinations of absorption on groups of flies for one particular period would be misleading. Furthermore, the amount of DDT acting at the primary site of action might be a better quantity to consider than the total DDT absorbed. Three sets of data from the literature on absorption of the applied dose are analysed in the light of these considerations, and it is concluded that an absorption effect can possibly lower the slope for a resistant strain because physico-chemical factors appear to set an upper limit to the amount of DDT that can reach the site in a given period, and thus a given increment in dose would increase the amount of DDT exerting a toxic action less in a high dose range than in a low one.

The second factor concerns the variability from fly to fly of the amount of DDT exerting a toxic effect at the primary site of action. It is shown that this variability would seem to be brought about, or greatly intensified, by the enzymatic detoxification of DDT in resistant flies. If a susceptible and a resistant strain differ in that flies of the latter can detoxify a proportion of the DDT that would otherwise exert a toxic action, the proportion detoxified can reasonably be expected to vary from one individual fly to another, and if the mean proportion detoxified is large, a relatively moderate variation in the proportion detoxified will result in a relatively large variation from fly to fly in the DDT remaining. Other things being equal, the slope of the line relating probit mortality to the logarithm of the external dose will then be substantially lower for the resistant strain. This and the absorption effect may occur together, reinforcing one another.

Bovingdon (H. H. S.). **An Apparatus for screening Compounds for Repellency to Flies and Mosquitoes.**—*Ann. appl. Biol.* **46** no. 1 pp. 47–54, 2 figs., 8 refs. London, 1958.

Fairly intricate laboratory apparatus has been designed for detecting the repellency and attractiveness of vapours for insects [*cf. R.A.E.*, B **37** 152, etc.; **47** 24], but techniques dealing with solids and liquids have hitherto called for only simple equipment [*cf.* **27** 250; **36** 88; **38** 99]. The more complicated apparatus here described was designed to evaluate the contact stimulus exerted on flies or mosquitos by compounds of low vapour pressure applied to glass. It consists of a cubic Perspex cage that has half of each inner surface covered by a glass plate and is mounted in a wooden open-fronted box in such a way that it can be turned periodically, so that the effects of variations of light, heat and other disturbing factors can be reduced to a minimum, and a stream of air can be slowly passed through it to prevent the accumulation of vapour from the test substance. Before the plates are bolted in position for a test, 1 ml. acetone solution of the test substance is applied to three of them, and 1 ml. acetone alone to the other three. About 35 flies or mosquitos are liberated in the cage, and the numbers settling on treated and untreated plates at intervals of one minute over a period of 40 minutes are counted. The position of the cage relative to the containing box is changed every five minutes. The quotient obtained by dividing the total number of insects on the untreated plates by the total number on the treated plates is called the "repellence quotient" and must reach certain given values before significance can be assumed and a compound regarded as repellent. The least values for three levels of significance for *Musca domestica* L. and *Stomoxys calcitrans* (L.) with one, two or three experiments are shown in a table. If a compound is found to be repellent at the first dilution tested (0·1 per cent.) it is retested at greater dilutions. Typical results of experiments with eight compounds against *M. domestica* are given and also the detailed determination of the repellency to *M. domestica* of butoxy polypropylene glycol (MW 800), which is used as a repellent against flies on cattle in the United States [*cf.* **39** 137]. This was the most repellent compound tested by the present technique, with a deduced threshold concentration of about 0·0008 per cent.

Steinhaus (E. A.) & Smith (R. F.). Ed. **Annual Review of Entomology. Volume 4.**—9 × 6 in., vii + 467 pp., illus., many refs. Palo Alto, Cal., Annual Reviews, Inc., 1959.

The reviews in this fourth volume of a series [*cf. R.A.E.*, B **45** 27; **46** 106, etc.], all of which are noticed elsewhere [A **47** 140], include: **Fleas and Disease,** by W. L. Jellison (pp. 389–414, 132 refs.), and **Insects and the Epidemiology of Malaria,** by P. F. Russell (pp. 415–434, 135 refs.), which includes a list of the species of *Anopheles* known to transmit malaria, showing the countries concerned, and another of the countries in which malaria occurs, showing its status in each and the Anopheline vectors responsible for transmission.

Mishin (A. V.). **The Aggressiveness of the Tick** *Ixodes persulcatus* **and a Method of studying it.** [*In Russian.*]—*Zool. Zh.* **35** pt. 7 pp. 978–985, 3 graphs. Moscow, 1956. (With a Summary in English, suppl. pp. 4–5.)

A knowledge of the seasonal variations in aggressiveness of Ixodid ticks is desirable for the planning of recreational and other activities in forest districts

in the Soviet Union, and the author describes how this was obtained for *Ixodes persulcatus* Schulze in 1952–54 near Izhevsk, in the Udmurt Republic. A special path nearly 600 yd. long and divided into three sections to form a rough triangle was cut in a remote part of the forest, and collections were made daily at fixed times by dragging, counting the ticks that adhered to the drags and to the operator at intervals of about 20 yd., and returning these to the ground from which they came. This was done throughout the tick season, and the counts obtained between 5 and 7 p.m. were used to construct a curve of aggressiveness for each year.

The results for 1953 and 1954 were rather similar, the numbers rising in late April or early May to a fairly sharp peak in early or mid-May and then declining gradually to lower values in early June and to still lower ones in July. In 1952, there was a rapid increase in numbers in the second half of May to a maximum that was twice as high as in either of the other years and was maintained, with variations, for about three weeks until mid-June, after which there was a sharp drop to low numbers in late June. In all years, small numbers were taken throughout July. The numbers are not essentially affected by ticks moulting to the adult stage, since further investigations showed that nymphs that engorged in May or the first half of June did not moult until the end of August and all those that engorged later overwintered and did not moult until early August, but they may be affected by differences in the date of emergence from hibernation and by changes in population resulting from crawling, though this last is held to be unimportant as ticks crawl very little. The fall in numbers later in the season is due not only to hungry ticks having engorged, but also to mortality, so that the curve does not only reflect a change in physiological condition.

Similar observations at different times of day showed that the numbers of ticks taken varied inversely with temperature, being high in the morning and evening and low at midday. The amplitude of the variation depended on the microclimate.

Shustrov (A. K.). **The Problem of the Distribution of Ticks of the Genus *Ornithodorus* in Transcaucasia.** [*In Russian.*]—*Zool. Zh.* **35** pt. 7 pp. 986–989, 18 refs. Moscow, 1956. (With a Summary in English, suppl. p. 5.)

Examples of *Ornithodoros verrucosus* Olen., Zas. & Fen. infected with relapsing-fever spirochaetes have been found on various occasions since 1933 in Transcaucasia and the Northern Caucasus. A second species of the genus, *O. alactagalis* Isaakyan, was recorded from Armenia in 1936, and this was also found naturally infected with spirochaetes, but it has been less frequently recorded and its wider distribution was unknown. Investigations were made in 1951–52 on the distribution of the two species in natural nidi of the disease in Transcaucasia, and the results, which are recorded in detail, showed that both occurred widely in the burrows of rodents and other mammals in Azerbaidzhan. They were frequently found in the same biotopes, although *O. alactagalis* was commoner in small burrows and *O. verrucosus*, which was the more numerous of the two, in medium and large ones. Adults of the latter from two places transmitted relapsing-fever spirochaetes to guineapigs on which they fed in the laboratory. *O. alactagalis* was also found in rodent burrows near Echmiadzin, in Armenia.

Teravskiĭ (I. K.). *Ornithodorus lahorensis* **Neumann as a Reservoir of Central Asiatic Tick-borne Relapsing Fever.** [*In Russian.*]—*Zool. Zh.* **35** pt. 12 pp. 1820–1824, 17 refs. Moscow, 1956. (With a Summary in English, suppl. p. 7.)

Ornithodoros lahorensis Neum. is widely distributed in Transcaucasia and Soviet Central Asia and often occurs there in natural nidi of tick-borne relapsing fever, but has frequently been found not to transmit the latter by bite [*cf. R.A.E.*, B **40** 211, etc.], the spirochaetes being confined to the digestive tract. In experiments, the defibrinated blood of a guineapig infected with Central Asian relapsing fever was injected into the body cavity of *O. lahorensis* by means of coxal puncture. Many of the ticks died after a few days, but some survived long enough for the fate of the spirochaetes to be determined. They were found to survive for only 7–9 days in the body cavity, and were not found in any of the internal organs, including the salivary glands. At no time were they transmitted to guineapigs by bite. The spirochaetes persisted for up to 24 days in the digestive tract of ticks that had fed on an infected guineapig, and they then disappeared; they remained mobile for only five days. Secretions of the gut and salivary glands had no effect on them. It is concluded that *O. lahorensis* provides an unfavourable environment for the spirochaetes and is of no importance as a reservoir for them in nature.

Petrishcheva (P. A.) & Saf'yanova (V. M.). **On the Problem of the Control of the Larvae of Black-flies (Simuliidae).** [*In Russian.*]—*Zool. Zh.* **35** pt. 12 pp. 1849–1852, 4 refs. Moscow, 1956. (With a Summary in English, suppl. pp. 9–10.)

Experiments on the control of Simuliid larvae were carried out in the summer of 1955 in a river and several streams, and irrigation canals in the Vladimir district, in which 18 species were found breeding. The apparatus used, termed a hydroborer, consisted of a thin metal pipe about 2 yd. long, attached to a pump by means of a hose and having a nozzle at the end through which the insecticide was released at a pressure of 4–6 atmospheres below the surface of the water, thus ensuring even distribution. The nozzle was directed, usually from the bank, towards the underwater parts of the vegetation on which the larvae and pupae were developing. Sections of a few yards were usually treated, but the effect extended for a considerable distance, as the insecticide was carried downstream by the current. The insecticides used were emulsion concentrates containing 16 per cent. BHC or 65 per cent. chlorten [chlorinated γ-pinene], which were diluted to 2 and 6·5 per cent., respectively, for use. Both proved very effective. In one larger test, in an irrigation canal about 2 yd. wide, some 1·5 gal. of the BHC concentrate was applied over a section about 100 yd. long. Complete control was achieved in a day down to the mouth of the canal, about 1,100 yd. away.

Pokrovskaya (E. I.). **Pathogenic Effect of the Bites of adult Ticks, *Dermacentor marginatus* Sulz., on their Host.** [*In Russian.*]—*Zool. Zh.* **36** pt. 2 pp. 214–218, 1 pl., 10 refs. Moscow, 1957. (With a Summary in English.)

Batches of 50–75 adults of *Dermacentor marginatus* (Sulz.) were allowed to engorge on guineapigs weighing 245–422 g. for observation of the effect on the animals. The guineapigs all died in 5–7 days, with 10–28 per cent. loss of weight, and showed losses of 30–50 per cent. of their supply of blood. Examination of their blood showed a reduction in haemoglobin and erythrocyte content, an increase in leucocytes, and erythrocyte degeneration. There were also effects on the skin, leading to inflammation and ulceration.

Helrich (K.), Hansens (E. J.) & Granett (P.). **Residues in Milk from Dairy Cattle treated with Methoxychlor for Fly Control.**—*J. agric. Fd Chem.* **6** no. 4 pp. 281–283, 4 refs. Easton, Pa., 1958.

In connection with tests on the control of biting flies on dairy cattle in New Jersey [*cf. R.A.E.*, B **46** 90, etc.], investigations were made on the residues of methoxy-DDT (methoxychlor) resulting in the milk of animals treated with this material. Emulsion sprays containing 0·5 per cent. methoxy-DDT with and without 5 per cent. butoxy polypropylene glycol (Crag Fly Repellent) were applied once a week on two farms and twice a week on a third, at a rate of about 1 U.S. quart per animal, and 7·6 g. 50 per cent. wettable powder alone or with 10 per cent. butoxy polypropylene glycol was applied per animal as a dust for four weeks, followed after a fortnight's interval by sprays of 0·5 per cent. wettable methoxy-DDT at 1 U.S. quart per animal, on a fourth. Analysis of milk samples taken at intervals during the treatment periods showed the presence of small amounts of methoxy-DDT, but these rarely exceeded 0·2 part per million, were usually considerably less, and diminished rapidly with time after each application [*cf.* **41** 16].

Arthur (B. W.) & Casida (J. E.). **Biological Activity of several O,O-Dialkyl Alpha-Acyloxyethyl Phosphonates.**—*J. agric. Fd Chem.* **6** no. 5 pp. 360–365, 1 graph, 23 refs. Easton, Pa., 1958.

The following is based mainly on the authors' summary. In view of the low mammalian toxicity of Dipterex (O,O-dimethyl 2,2,2-trichloro-1-hydroxyethylphosphonate), several O,O-dialkyl 2,2,2-trichloro-1-acyloxyethylphosphonates and related derivatives were compared for toxicity to *Musca domestica* L. and rats and for anticholinesterase activity. The most selectively toxic was O,O-dimethyl 2,2,2-trichloro-1-n-butyryloxyethylphosphonate, termed butonate, which was as effective as Dipterex against the fly but much less toxic than Dipterex to rats. Studies of metabolism in various insects and rats and also *in vitro* with mammalian tissue showed that it was hydrolysed at the acyl group, the phosphorus-carbon bond, and possibly the phosphorus-oxygen-methyl bond. The initial site of *in vivo* hydrolysis appeared to be a major factor in its selective toxicity.

Papers noticed by Title only.

Metselaar (D.). **A Pilot Project of residual-insecticide Spraying to control Malaria transmitted by the** *Anopheles punctulatus* [Dön.] **Group in Netherlands New Guinea.**—*Amer. J. trop. Med. Hyg.* **5** (1956) no. 6 pp. 977–987, 2 graphs, 14 refs. Baltimore, Md., 1957. [For fuller account see *R.A.E.*, B **46** 1.]

Giang (P. A.) & Caswell (R. L.). **Polarographic Determination of O,O-Dimethyl 2,2,2-Trichloro-1-hydroxyethylphosphonate (Bayer L 13/59)** [(Dipterex) in technical products and formulations].—*J. agric. Fd Chem.* **5** no. 10 pp. 753–754, 11 refs. Easton, Pa., 1957.

Norris (M. V.), Easter (E. W.), Fuller (L. T.) & Kuchar (E. J.). **Colorimetric Estimation of Malathion Residues in Animal Products.**—*J. agric. Fd Chem.* **6** no. 2 pp. 111–114, 4 refs. Easton, Pa., 1958.

EDITORIAL

The late Sir Guy A. K. Marshall

Entomologists throughout the world, and particularly in the British Commonwealth, will learn with deep regret of the death of Sir Guy Marshall in London on Wednesday, April 8th, at the age of 87.

He was the " Father " of the present Commonwealth Institute of Entomology and indeed of the Commonwealth Agricultural Bureaux as a whole, for from his small beginning as Secretary of the Colonial Entomological Research Committee (Tropical Africa) in 1909, with a budget of £2,000 per annum, stemmed the Imperial Bureau of Entomology, on which were subsequently modelled the two other Institutes and ten Bureaux, covering practically all branches of agricultural science, that are now included in the organisation, of which the present annual budget is nearly £300,000. The Commonwealth Institute of Entomology will stand as a permanent memorial of his great services to economic entomology.

There were two incidents in Marshall's early life that had far-reaching effects. In 1907 he was appointed Curator of the Sarawak Museum, but was taken seriously ill just before he was due to sail. This apparent disaster left him available for the much more important work that he was to embark on two years later. The second incident was the accident that led to his taking up the study of weevils. He made a collection of beetles in Rhodesia and was returning to England from Salisbury in 1896. At the last minute, it was found that the coach in which he was to travel to Beira could not take a large air-tight box that contained the main part of the collection. This was left behind to be shipped later, but was never heard of again, so he arrived in England with one box containing the remainder of the beetles, which happened to be weevils. These he studied at the British Museum. When he returned to South Africa, he had to remain in Natal on account of the war. Here he spent his time studying the genus *Apion*, having found that he had 90 species in his collection, whereas only ten had previously been described from South Africa.

During his 28 years as Director of the Institute, Marshall found time to carry on his work on weevil classification, despite his numerous other duties. He became the recognised authority on this very large family, especially on the African and Oriental species. Large quantities of insect material are sent to the Institute for determination, including considerable numbers of weevils. Marshall rendered a great service to workers overseas by his prompt handling of this material. Even after he retired in 1942, and until a few weeks before his death, he worked constantly at the Museum and continued to determine all weevils sent to the Institute.

Marshall exercised a profound influence on the development of applied entomology in the Commonwealth, not only through the Institute that he built up so efficiently with the aid of Dr. Sheffield Neave, who was Assistant Director from 1914 to 1942, but also as Adviser to the Colonial Office on entomological matters. But entomologists from overseas will remember him more for his wise and kindly advice, and the stimulation, inspiration and help they received at his hands. He was always ready to see workers from abroad and to discuss their problems with them. He leaves behind a host of friends who will cherish his memory.

Ascher (K. R. S.). **Prevention of Oviposition in the Housefly through Tarsal Contact Agents.**—*Science* **125** no. 3254 pp. 938–939, 14 refs. Lancaster, Pa., 1957.

Several compounds were tested in Israel to determine whether they would significantly reduce oviposition by house-flies (*Musca domestica* L.) when used as contact agents in sublethal doses [*cf. R.A.E.*, B **44** 77–78], and two of them proved outstanding. These were di(p-chlorophenyl)-trifluoromethyl-carbinol [DTFMC] (I) and di(p-chlorophenyl)-pentafluoroethyl-carbinol (II). Di(p-bromophenyl)-trifluoromethyl-carbinol and di(p-chlorophenyl)-heptafluoropropyl-carbinol showed lower activity. When the chlorine atoms in I were replaced by methyl or methoxyl groups, the activity disappeared completely, and replacement of the fluorine atoms in I by chlorine, to give di(p-chlorophenyl)-trichloromethyl-carbinol (DTMC) resulted in low activity. Di(p-chlorophenyl)-dichloromethyl-carbinol and DMC [di(p-chlorophenyl)-methyl-carbinol] were completely inactive.

The effect on oviposition of treatment with compounds I and II, which have some contact toxicity, was investigated on females of a Swiss strain of *M. domestica* highly resistant to them. The flies were taken when three days old from cages containing mixed populations of males and females that had fed on water and sugar only. They were then treated with one of the compounds by one of several methods and introduced with equal numbers of untreated males into fresh cages. When the compounds were administered daily at 0·01 per cent. in milk or the flies were exposed to them as vapour on the third day and milk was offered on the fourth day only, oviposition was normal. When the compounds were applied topically in acetone at 1 μg. per female and milk was offered on the next day, there was no oviposition; when females were exposed for 30 minutes to a deposit of 1 g. per sq. m. in petri dishes and milk was offered on the next day, there was no oviposition with compound I and practically none with compound II, and when filter paper of an area equal to the area of one side of the cage was impregnated with 1·5 g. per sq. m. and hung in the centre of the cage and milk was offered daily, there was very little oviposition with compound I and none with compound II. Controls oviposited normally. It was thus possible to counteract the influence of continuous feeding with milk by continuous exposure to compound I or II. Tarsal contact with smaller quantities than 1 g. per sq. m. or for less than 30 minutes delayed or drastically reduced oviposition. Continuously available milk, with topical or tarsal application, outweighed the effect of the compounds. Females that had been continuously exposed to the compounds were found on dissection to have abundant motile spermatozoa in the spermathecae and normally developed ovaries containing eggs.

Wallis (R. C.). **Host Feeding of** *Culiseta morsitans*.—*Proc. ent. Soc. Wash.* **59** no. 4 pp. 199–200, 7 refs. Washington, D.C., 1957.

The host-preferences of mosquitos that feed on birds in the eastern United States are important because of the part played by birds, and particularly pheasants, as reservoirs of eastern equine encephalitis [*cf. R.A.E.*, B **29** 38], but little information is available for many species. Special attention has recently been paid in Connecticut to species of *Culiseta*, in view of isolations of the virus from *C. melanura* (Coq.) [*cf.* **45** 97] and in particular three from collections made in New Jersey near a pheasant pen. Adults of *C. morsitans* (Theo.) were collected regularly from diurnal resting places near a domestic pheasant pen in Connecticut in the early summer of 1956, and it was found that in the four-week periods before and after 14th July, when young

pheasants were put in the pens, 2·6 per cent. of 115 females and 35·2 per cent. of 88 females examined, respectively, contained blood. Microscopic examination of smears from six blood-fed females showed that all contained nucleated red blood cells. The sharp increase in the number of females containing blood could not be connected with any change in the populations of wild birds or other potential hosts, or of the environment generally, other than the introduction of the pheasants. The proportion of engorged females caught during the first week after the pheasants became available was considerably higher than in the subsequent ones, and, although alternative explanations are possible, it is concluded that a population of females ready to feed had built up and that the young pheasants provided a suitable source of food. This is the first record of the finding of blood-engorged females of *C. morsitans*.

Dissanaike (A. S.), Dissanaike (G. A.) & Niles (W. J.). **Production of radioactive infective Larvae of** *Wuchereria bancrofti* **in** *Culex fatigans*. —*Exp. Parasit.* **6** no. 1 pp. 52–59, 5 refs. New York, N.Y., 1957.

Attempts to obtain radioactive infective larvae of *Wuchereria bancrofti* were made by making adults of *Culex pipiens fatigans* Wied. radioactive by inclusion of radiophosphorus (^{32}P) or radiostrontium (^{89}Sr) in the breeding medium of the second- and third-instar larvae or, in a few cases, by feeding adults on sugar solution containing orthophosphate to give 7·5 μc. per ml. or strontium chloride to give 5 μc. per ml. The intake of ^{32}P from sugar solution was low and that of ^{89}Sr negligible. Marking with strontium in the rearing medium was not successful, as mortality of larvae was high, even in baths giving as little as 0·05 μc. per ml. and the few adults emerging had low β-activities but could not feed. The results, which were not in agreement with some obtained with *Aëdes aegypti* (L.) [*cf. R.A.E.*, B **46** 207], suggest that the observed ill-effects were chemical. Rearing larvae in water containing ^{32}P at 0·025, 0·1 and 1 μc. per ml. produced adults of high radioactivity, which increased with increasing concentration of ^{32}P, but adults emerging from the strongest concentration showed signs of retarded growth and the females did not feed. An account of the production of radioactive infective larvae of *W. bancrofti* in females emerging from the larvae reared in water containing 0·1 μc. per ml. has already been noticed from a briefer source [**46** 129].

Hadaway (A. B.) & Barlow (F.). **Some Aspects of the Effect of the Solvent on the Toxicity of Solutions of Insecticide.**—*Ann. appl. Biol.* **46** no. 2 pp. 133–148, 1 graph, 8 refs. London, 1958.

The effect of the solvent on the contact toxicity of insecticide solutions to females of *Aëdes aegypti* (L.) and *Musca domestica* L. was investigated by allowing the insects to walk for a limited time on impregnated filter papers [*cf. R.A.E.*, B **41** 156] in a closed tube and by topical application [**42** 118]. The insecticides used were DDT, Prolan (1,1-di(p-chlorophenyl)-2-nitropropane), dieldrin, endrin and malathion. The filter papers were impregnated with solutions of various concentrations at 0·0045 ml. per sq. cm., and exposure time was kept constant at one hour. Preliminary experiments with DDT had shown that the product of concentration and exposure time needed to give 50 per cent. kill was constant. The insecticides were so chosen that there was no fumigant action at the highest concentration used.

The following is largely based on the authors' summary of the results. The filter-paper tests showed that the chemical structure of the solvents had

a general influence on the biological activity of the solutions [*cf.* **31** 23], probably through its influence on their power to disrupt and disperse, if not dissolve, the protective waxes of the outer layers of the insect cuticle. Providing that the physical properties of the solvents were similar, insecticides were more effective in paraffinic hydrocarbons than in aliphatic long-chain esters and related compounds, and were least effective in aromatic esters and triglycerides. The physical properties of the solvents (*e.g.*, molecular weight, boiling point or range, surface tension and viscosity) were important in determining the effectiveness of insecticides dissolved in a group of solvents of similar chemical structure. Viscosity was an especially reliable guide, presumably because of a controlling effect on the rate at which the solution could pass from the paper and be absorbed by the insects during the exposure period. The order of effectiveness for the solutions in different solvents was the same for all the insecticides used, but the ratios between the median lethal concentrations varied greatly from one insecticide to another. Consequently, the relative toxicities of the insecticides depended on the solvent in which they were dissolved.

When some of the solutions used in the filter-paper tests were applied topically, the differences in effectiveness were much smaller, showing that an important effect of the solvent had been its influence on the amount of insecticide picked up from the papers. However, even with topical application, there were differences in the median lethal concentrations and particularly in the rates of action of the insecticides in different solvents. This provided further evidence that the solvent is concerned with the passage of insecticides through the insect cuticle. The relative toxicities of the solutions bore no relation to the solubilities of the insecticides in the solvents, and it was concluded that chemical potential [**35** 9; **42** 170] was not likely to be a controlling factor in these experiments.

Donnelly (J.). **Methods for the Study of Blowfly Populations. III. The Fate and Distribution of ^{32}P in Blowflies labelled in the larval Stage.**— *Ann. appl. Biol.* **46** no. 2 pp. 243–253, 1 graph, 8 refs. London, 1958.

In this third paper of a series [*cf. R.A.E.*, B **44** 113; **45** 58], a simple method is described whereby larvae of *Lucilia sericata* (Mg.) were made radioactive through the inclusion of radioactive material (^{32}P) in the rearing medium. Flies with more uniform counts were obtained in this way than by labelling in the adult stage [**45** 185], and counts were more uniform in individuals that had fed entirely on radioactive foods than in those that had fed for the first day on non-radioactive food. The counting rates of the larvae were correlated with larval live weight, and those of the resulting adults both with the corresponding rates of the larvae and with adult live weight. The loss of ^{32}P from causes other than decay of the isotope is traced from the prepupal stage to three weeks after adult emergence, and a graph is given enabling effective counting rates during this period to be predicted, provided that the original post-feeding rate is known. The first and major loss occurs at emergence, when 10–15 per cent. of the original ^{32}P is shed with the empty puparium and meconium. Counting rates for adults at emergence are nevertheless slightly higher than those for pupae [*cf.* **39** 181], almost certainly because of differences in the bulk and shape they present to the Geiger-Müller tube. Adults lose about 1·5 per cent. of their radioactivity per day. The distribution of ^{32}P in the cuticle and various other parts of the adults of *L. sericata* that had been labelled in the larval stage was shown to be fairly uniform, the average number of counts per sec. per mg. dry weight varying in the male and (in brackets) female from 9 to 10·7 (8·5 to 9·8), except in the abdominal tissues and wings, which

showed 5·8 (5·1) and 5·3 (4·4), respectively. There was fairly close agreement between the sexes in the relative proportions of ^{32}P in the various parts, and the slightly higher counting rate per mg. dry weight for the males probably reflected the higher activity per mg. live weight that had been shown by this sex in the larval stage.

PHIPERS (R. F.) & WOOD (M. C.). **An Investigation into the reported Stabilisation of Pyrethrins by Piperonyl Butoxide.**—*Pyrethrum Post* **4** no. 2 pp. 11–12. London, 1957.

BROOKE (J. P.). **The Stabilization of Pyrethrins by Piperonyl Butoxide in Water, with special Reference to their Use as Mosquito Larvicides.**—*Ann. appl. Biol.* **46** no. 2 pp. 254–259, 1 graph, 6 refs. London, 1958.

The first of these papers comprises an account of an investigation into the effect of piperonyl butoxide on the stability of pyrethrins exposed to artificial light, available evidence on which is conflicting [*cf. R.A.E.*, A **40** 1, 297–298; B **41** 61]. Films of pyrethrum extract alone and a 1:8 mixture of pyrethrum extract and piperonyl butoxide were exposed for varying periods to irradiation from two 150-watt tungsten lamps and one 80-watt high-pressure mercury lamp, and the amount of true pyrethrins remaining was then assessed by a colorimetric method, so that the synergistic effect of the piperonyl butoxide did not influence the results. In the film from the pyrethrum extract alone, only 7 per cent. of the true pyrethrins remained after four days, whereas in that of the mixture 64 per cent. remained after five days. This was not due to the solvent effect of the piperonyl butoxide because when similar tests were made with pyrethrins in either mineral oil or butoxy polypropylene glycol (Crag Fly Repellent), which, like piperonyl butoxide, is a polar solvent, the percentages of pyrethrins persisting were reduced to 8 after three days for the oil and 17 after five days for the glycol. The longer persistence was not due to any relation between stabilisation and synergism, for when a commercial synergist stated to be butoxyethoxyethyl piperonylate was substituted, only 7 per cent. of the pyrethrins remained after five days.

In the second paper, an account is given of investigations on the synergistic effect of piperonyl butoxide on pyrethrins in water and its influence on their stability, undertaken with a view to their possible use against larvae of *Aëdes aegypti* (L.). To determine synergistic effect, solutions were prepared in ethyl alcohol containing 5–25 parts per million w/v pyrethrins alone, and 1–10 p.p.m. pyrethrins with ten and 20 times as much piperonyl butoxide, and colloidal dispersions were made from them by diluting 1 ml. solution with 99 ml. tap water and mixing 10 ml. of this dispersion with 90 ml. tap water in a conical flask. When the temperature of the dispersions was 25°C. [77°F.], batches of 50 larvae of *A. aegypti*, 48 hours old and reared under uniform conditions, were placed in them and their mortality was determined 24 hours later by means of an apparatus similar to that described by Burchfield, Hilchey & Storrs [A **42** 76], which made use of the sensitivity of the larvae to light. The factors of synergism at LD50 level with the two concentrations of piperonyl butoxide were found to be 3 and 3·6, respectively.

For stability tests, emulsifiable concentrates containing 5 per cent. pyrethrins with and without 50 per cent. piperonyl butoxide were prepared and diluted in water to give concentrations of 0·05, 0·1 and 0·43 p.p.m. pyrethrins, and a solution of 0·2 per cent. pyrethrins and 2 per cent. piperonyl butoxide in ethyl alcohol was diluted to give 0·43 p.p.m. pyrethrins. The diluted preparations were exposed to summer daylight in open-topped steel drums placed in a window, and samples were withdrawn

for biological tests 24 hours after preparation and at weekly intervals thereafter. Piperonyl butoxide prolonged the activity of the pyrethrin emulsions against the larvae at every concentration, with most effect at the highest, which prolonged the period during which complete mortality was effected in 24 hours from two to 14 weeks. The solution in ethyl alcohol gave complete control for eight weeks. An emulsion without insecticide caused no mortality. Experiments were also made with sachets and briquettes. The sachets were made of polythene sheet 0·004 in. thick (which is pervious to pyrethrins and piperonyl butoxide) and were filled with 6 g. of a mixture of china clay and kieselguhr containing 1 per cent. w/w pyrethrins and 10 per cent. piperonyl butoxide, and the briquettes were prepared from 10 g. of the same powder, 10 g. fine builder's sand and 5 g. cement. Both were designed with a view to providing a reservoir of insecticide in containers storing drinking water [*cf.* B **45** 131], which are frequently replenished. Sachets were suspended below the surface of water contained in drums, and briquettes were placed on the bottom. Insecticide liberated from either remained completely effective for 19 weeks, the duration of the experiment. Half the water was replaced after ten weeks, and the briquette gave complete mortality of larvae 12 hours later, but the sachet did not do so until more than a week had elapsed. When mud, collected from a local stream, was added to 5 litres water in beakers at 10 g. per l., inactivation of the insecticide, whether from an emulsion or a sachet was rapid; preparations stored in daylight, in which algae quickly formed, were affected sooner than those stored in darkness, but algae alone had no apparent effect on the insecticide.

It is evident that the addition of piperonyl butoxide prolonged the biological activity of the pyrethrins for longer than would be expected from its synergistic activity alone. At a concentration of pyrethrins of 0·43 p.p.m., mortality fell to 31 per cent. after four weeks; with a factor of synergism of 3, the addition of piperonyl butoxide would not give complete mortality at this time, yet such was obtained every week for 14 weeks. Pyrethrins with piperonyl butoxide as synergist and stabiliser may therefore provide a safe insecticide for the control of larvae of DDT-resistant strains of *A. aegypti* [B **46** 150, etc.] in containers storing domestic water.

Glushchenko (P. A.), Gutsevich (A. V.) & Dudkina (M. S.). **Investigation of Mosquitos as Vectors of the Virus of Lymphocytic Choriomeningitis in the western Ukraine.** [*In Russian.*]—*Dokl. Akad. Nauk SSSR* **113** no. 5 pp. 1181–1183, 5 refs. Moscow, 1957.

The virus of lymphocytic choriomeningitis has been found to be transmitted by Gamasoid mites in the Soviet Union and by the bite of *Aëdes aegypti* (L.) in the laboratory elsewhere [*R.A.E.*, B **32** 62]. Investigations on the possible part played by mosquitos in the circulation of the virus in nature were made in the western Ukraine in 1956. Mosquitos were captured in wooded environments, far from centres of habitation, in July–August, when temperatures were high and would therefore favour multiplication of viruses, and since mosquitos are not known to transmit viruses through the egg, the selection of examples that had passed through at least one gonotrophic cycle was desired. This was done by observations on the cessation of adult emergence from breeding places and subsequent classification of samples according to their physiological age [**34** 180, etc.]. Since adults of some species of *Aëdes* are difficult to identify after they have lost part of the scales from the thorax and wings, mosquitos of such species were assigned to groups. The group of *A. communis* (Deg.) consisted of 70 per cent. *A. diantaeus* H., D. & K., 20 per cent. *A. sticticus* (Mg.), 9–10 per cent. *A. punctor* (Kby.) and a few examples of *A. communis* itself, and the group

of *A. maculatus* (Mg.) comprised 95 per cent. of that species and 5 per cent. of *A. excrucians* (Wlk.). Suspensions were prepared from batches of not more than 50 mosquitos and injected intracerebrally into white mice. At least four passages were made, and mice of the fourth passage were observed for three weeks, after which the final results were drawn up. In all, 43 batches of mosquitos were investigated, and the final results showed that 13 strains of the virus were isolated from 30 batches of the group of *A. communis*, comprising 1,442 examples, two from four batches of the group of *A. maculatus*, comprising 130 examples, two from four batches of *Mansonia richiardii* (Fic.), comprising 113 examples, one from two batches of *A. cinereus* Mg., comprising 99 examples, one from a batch of 50 examples of *A. geniculatus* (Ol.), and none from a batch of 40 examples of *A. vexans* (Mg.) or one of 50 examples of *Anopheles claviger* (Mg.) (*bifurcatus*, auct.). Two of the strains were isolated from *M. richiardii* and the group of *Aëdes communis* in the originally infected mice, and the remainder during the first, second or third passage. All the strains caused death of the mice in 5–6 days, with typical symptoms of lymphocytic choriomeningitis.

In 1954, the first author isolated a strain of virus (17-MK) from *Ixodes ricinus* (L.) that was identified from its immunological properties as the virus of lymphocytic choriomeningitis. The ticks were collected in the same districts as the mosquitos, and it is therefore concluded that mosquitos, ticks and mites are vectors of the virus and play a part in its circulation.

Olenov (Yu. M.). **The Rôle of Selection and direct Adaptation in the Increase of Resistance to the Action of Insecticides.** [*In Russian.*]—*Dokl. Akad. Nauk SSSR* **118** no. 2 pp. 414–416. Moscow, 1958.

F_1 females of 20 lines of *Drosophila melanogaster* Mg. derived from wild adults caught near Idritsa in August 1955 proved about as susceptible to contact with a DDT deposit as females of a susceptible laboratory strain, and no increase in resistance occurred in 30–40 generations when the larvae were reared in a medium containing a sublethal concentration of DDT. When, however, selection without exposure to DDT was tested by inbreeding brothers and sisters of the most resistant flies in each generation, a very considerable increase in resistance was evident in five generations, but the inbreeding had resulted in serious loss of fertility. The experiment was therefore continued by breeding from unexposed flies of the most resistant mass cultures. Resistance continued to increase; it was 100 times as great after 11 generations as it had been initially, and its level was maintained in subsequent generations reared in the same way.

Busvine (J. R.). **Insecticide-resistant Strains of Insects of Public Health Importance.**—*Trans. R. Soc. trop. Med. Hyg.* **51** no. 1 pp. 11–31, 75 refs. London, 1957.

The increase of resistance to insecticides in disease-carrying insects in 1946–55 is briefly described, and the position in regard to house-flies (*Musca domestica* L., including *M. d. nebulo* F. and *M. d. vicina* Macq.), mosquitos, *Pediculus humanus humanus* L., *Cimex lectularius* L., *C. hemipterus* (F.), *Blattella germanica* (L.) and various species of fleas is reviewed; the progress of research on the development of resistance, and the many lacunae in present knowledge revealed by this, are discussed.

The problems of resistance appear to be growing faster than ability to deal with them, and there is an urgent need to know whether resistance can develop in any insect to any insecticide that is used extensively and for

long enough. The chances of its rapid development may depend on the frequency and importance of naturally occurring genes for resistance, or the intensity of selection as determined by the size of the population exposed to the insecticide and the proportion killed, or on the number of generations per year; the last, however, is unlikely to be of overwhelming importance, since *B. germanica*, which has only $2\frac{1}{2}$ generations a year, developed resistance as quickly as *Aëdes aegypti* (L.), which has 30.

Naturally occurring resistance genes are probably very rare before concentration by selective mortality resulting from the application of insecticides. The existence of two kinds of such genes is suggested, one giving low-level generalised resistance or " vigour tolerance " and the other specific protection from a particular type of poison. Resistance of the first kind, which may be due to such heritable characters as size, resistance to starvation or desiccation, reduced permeability of the cuticle or increased lipoids in the body [*cf. R.A.E.*, B **47** 8], is likely to promote survival after contact with any insecticide and might be expected to be controlled by multiple genes; it would seem likely to develop in any species subjected to an insecticide for long enough on a sufficient scale. Resistance of the second type, which is of a higher order and is specific, appears to be conferred by genes, at least in some instances single ones, that promote a biochemical defence mechanism, either in the form of a detoxifying enzyme or by the introduction of a metabolic system unaffected by the poison. This kind of resistance is considered in relation to DDT and analogous compounds, to γ BHC and the chlordane group [*cf.* **44** 111], now found to include endrin and isodrin, and to the organic phosphorus compounds. Resistance to DDT appears to depend on more than one defence mechanism, for although dehydrochlorination seems to be essential to resistance in *Aëdes* and is an important factor in resistance of some strains of *M. domestica*, it is probably unimportant in *P. humanus humanus* [*cf.* **46** 168]. Resistance to γ BHC and the chlordane group has been found to depend, in several different species [*cf.* **44** 111, **45** 68], on a mechanism the exact nature of which is unknown [*cf.* **45** 30], though it is suggested that the development of a metabolic path insensitive to this type of poison may be the common resistance factor. Comparatively little is known about resistance to the organic phosphorus compounds, but the use of parathion, diazinon [O,O-diethyl O-2-isopropyl-4-methyl-6-pyrimidinyl phosphorothioate] or Bayer 21/199 [O,O-diethyl O-3-chloro-4-methyl-7-coumarinyl phosphorothioate] against *M. domestica* in Denmark caused resistance to all three. The author found that a strain of which over 100 generations had been exposed in the laboratory to the vapour of DFP [di-isopropyl phosphorofluoridate] showed about threefold resistance to a wide range of organic phosphorus compounds; the resistance was reduced if the insecticide was injected, which suggested that it was caused by reduced penetration of the cuticle [*cf.* **46** 77].

The effect of intensity of selection on the rate of the development of resistance involves both genetical and ecological considerations. In general, the more intense the selection in each generation, the more rapid the development of resistance, though King's results [**43** 99] conflicted with this, possibly because the very small numbers of survivors at the intensive rate of selection curtailed genetic variability. Gene frequency will also affect rate of emergence of resistance. When the genes are rare, as they probably are in most original populations, rate of selection will be slow, but progress will accelerate as they become more concentrated. When selection is relaxed, the return to susceptibility will follow the same course, in reverse. Unfortunately, the adverse effects associated with some resistance genes in the absence of insecticide are fairly mild, so that the return to susceptibility will be slower than the rise of resistance, and there should be a long period in which resistance genes are in a minority but not very rare; during this, they

can rapidly be concentrated again if selection is reintroduced. Certain checks to selection, such as linkage of resistance genes to others that protract development or reduce fertility, have been observed in the laboratory, but corresponding field data are lacking. There are few quantitative data as to the ecological aspects of resistance in the field. It has been suggested that regular use of larvicides against mosquitos produces resistant strains more readily than measures against the adults alone, probably because the insecticide reaches a much larger proportion of the natural population. Selection by an insecticide may alter characters other than physiological resistance. For instance, exposure of mosquitos to insecticide deposits in houses may encourage the development of a zoophilous or non-domestic race [*cf.* **43** 177].

Possible counter-measures against resistance include various means of prevention, early detection, by adequate tests, of the susceptibility of the population both before and at intervals after operations have started, and cure. Though fragmentary basic knowledge of resistance makes recommendations for prevention difficult, it is suggested that, since resistance appears likely to develop more rapidly in response to high dosage, measures should aim at the lowest level of control adequate to prevent transmission of disease organisms, and that good alternative insecticides should be reserved for use in epidemics; the practical value of alternation of insecticides is reduced by the long period that is needed for resistance to disappear, which might amount to about 10 years in the control of *M. domestica* by DDT and only a two-year period of effectiveness afterwards; the use of mixtures of insecticides also is considered unlikely to be advantageous. For cure, increased dosage or a more efficient method of application might overcome existing low-level general resistance, but would be unlikely to be of assistance against high-level specific resistance. Ignorance of the toxicology of insecticides leaves the use of alternative insecticides as the only course open, but this is of limited practical value, as the three types of resistance discussed cover most of the effective new synthetic insecticides. Changing to the use of means of control other than insecticides may be possible in the last stages of a campaign.

In the discussion that followed, G. Davidson questioned the statement that cessation of control measures before complete resistance is attained must result in reversion to susceptibility. If selection by insecticides ceases in a population consisting mainly of resistant and hybrid individuals, the result may well be a population of resistant individuals only, because such individuals may dominate in competition with susceptible ones, and hybrid interbreeding, which produces pure susceptibles, may be reduced through the sterility of the hybrid males that results from crosses between resistant females and susceptible males.

Lawley (B. J.). **The Discovery, Investigation and Control of Scrub Typhus in Singapore.**—*Trans. R. Soc. trop. Med. Hyg.* **51** no. 1 pp. 56–61, 1 map, 4 refs. London, 1957.

An outbreak of tsutsugamushi disease (scrub typhus) with nine confirmed and eight possible cases occurred in 1952–53 among people living or working at the Royal Air Force Station at Changi on Singapore Island. Examination of rats trapped in two months early in 1953 from the five areas of waste land in and around the camp showed those from one of them to be infested with Trombiculid mites. Further investigations between June and December showed that the infested rats, identified as *Rattus rattus diardii*, were confined to this area, which occupied about 100 acres and was bounded by main roads. There were 60–1,000 mites, mainly *Trombicula deliensis* Walch., per rat, the average being about 400. *Rickettsia orientalis* was recovered from

some of them. Rats that were freed of mites, marked, released and recaptured were nearly always recaught near the site of original capture and, with the exception of one taken 700 yards away, were again heavily infested.

Human infection was associated with the mite-infested area. No further cases occurred after the area had been put out of bounds to servicemen off duty, civilians had been advised not to visit it and servicemen required to be in it on duty had impregnated their clothing with dibutyl phthalate. In January 1954, the area was sprayed from the periphery inwards with dieldrin at 2·2 lb. per acre [*cf. R.A.E.*, B **43** 102] and a rat-killing campaign was also carried out in the final week of the treatment. Rats caught during the following months were free from mites, the area was returned to full use and no further cases of the disease occurred.

Quan (S. F.), Hartwell (W. V.), Scott (K. G.) & Peng (C. T.). **Cerium 144 as a Tag for Arthropods of medical Importance.**—*Trans. R. Soc. trop. Med. Hyg.* **51** no. 1 pp. 87–88. London, 1957.

Radioactive phosphorus (^{32}P) and iodine (^{131}I), the isotopes generally used for marking insects with radioactive tracers [*cf. R.A.E.*, B **43** 100], have a relatively short half-life [*cf.* **46** 207], and radioactive cerium (^{144}Ce) has been found to supply the want for an isotope that has a longer one. It emits a β-particle and a γ-ray, and its half-life is 282 days; it has a short-lived daughter, praseodymium (^{144}Pr), and this has a half-life of 17·5 minutes and emits a very energetic β-particle, which can be readily detected and measured. Cerium appears to form stable combinations with tissues. Fleas (females of *Malaraeus telchinum* (Roths.), *Xenopsylla cheopis* (Roths.) and *Hystrichopsylla* sp.) and ticks (*Ixodes* sp.) were marked by immersion for less than five minutes in aqueous solutions of ^{144}Ce–^{144}Pr containing 10 μc. per ml., mosquitos (*Aëdes aegypti* (L.)) by rearing them from late fourth-instar larvae and pupae kept in water containing less than 10 μc. per ml., and anaesthetised individuals of *Triatoma protracta* (Uhl.) and *Blattella germanica* (L.) by the topical application of less than 1 μl. solution containing about 1 μc. per ml. to their backs. No detectable amount of the isotopes could be removed by washing the arthropod with a 5 per cent. solution of ethylenediaminetetraacetic acid. The amounts of the isotope mixture retained by the various species after seven days in counts per individual per minute ($\times 10^2$), were, respectively, 3·9–4·5, 1·5–2·3, 60–70, 10–11, 0·7–1, 13·5–16 and 3–4. These figures were only very slightly lower than those obtained after one day. The method of tagging is simple, rapid and needs no special equipment. A disadvantage of the use of cerium is that further studies with other γ- or β-emitters cannot be carried out in an area in which it has been used until the tagged insects have died or until enough time has elapsed for decay of the ^{144}Ce to background levels.

Proceedings of the Tenth International Congress of Entomology, Montreal, August 17–25, 1956. Section on Systematics.—*Proc. 10th int. Congr. Ent.* **1** pp. 87–465. Ottawa, 1958.

The following are abstracts of selected papers containing hitherto unpublished information of which the text is printed in full in this section [*cf.* also *R.A.E.*, A **47** 176].

Micks (D. W.) & Partridge (M. H.). **Differentiation of Mosquito Extracts by their Infrared Spectra,** pp. 383–386, 4 graphs, 12 refs. The following is virtually the authors' abstract. Aqueous and carbon-bisulphide extracts of *Aëdes aegypti* (L.), *A. pseudoscutellaris* (Theo.), *Culex pipiens*

fatigans Wied., *C. p. molestus* Forsk. and *Anopheles quadrimaculatus* Say were prepared by homogenising whole specimens in a tissue grinder. After centrifugation, the clear supernate was spread on silver chloride plates. The specimens were dried at 37°C. [98·6°F.] and analysed within 24 hours of preparation. The infra-red absorption spectra from 2 to 16 μ were determined with a Baird double-beam recording instrument equipped with a sodium-chloride prism. The aqueous extracts of the various species could be distinguished by qualitative differences in the 6–11 μ portion of the curve. The most important differences were the relative shapes and intensities of the peaks from 6·8 to 7·1 μ and the relative depth and shape of the broad band from about 8·6 to 10·6 μ. When aqueous extracts were prepared from 7–14 day-old specimens, certain spectral changes occurred. The carbon-bisulphide extracts of the different species could not be differentiated consistently [*cf.* B **44** 205].

Stephen (W. P.). **Hemolymph Proteins and their Use in Taxonomic Studies,** pp. 395–400, 2 figs., 9 refs. Since comparative protein analysis, which distinguishes large categories of organisms qualitatively, might be useful for differentiating between populations of polytypic forms, the haemolymph proteins of adult female insects of seven species were studied by procedures that are described. *Periplaneta americana* (L.) and *Blatta orientalis* L. showed a quantitative and qualitative similarity in two of the protein fractions found; a third fraction was peculiar to *B. orientalis*, but occurred in only trace amounts. The other species used, which comprised *Oncopeltus fasciatus* (Dall.), *Phormia regina* (Mg.), *Smerinthus cerisyi* Kby., *Pleocoma minor* Linsley and *Lichnanthe rathvoni* (Lec.), showed considerable differences in protein fractions.

McClellan (D. B.) & Moore (J. B.). **Determination of Allethrin Residues in Milk and Meats.**—*J. agric. Fd Chem.* **6** no. 6 pp. 463–465, 3 refs. Easton, Pa., 1958.

The following is substantially the authors' summary. A colorimetric method accurate to 0·1 part per million is presented for the determination of allethrin in the milk or meat of farm animals subjected to this material in a concentrated spray. No allethrin was found in the milk of dairy cows sprayed daily for three weeks with up to 20 per cent. allethrin in deobase or in the meat tissues of a female goat sprayed daily for five weeks with 20 per cent. allethrin in deodorised kerosene, both at the rate of 1·5 oz. spray per animal.

Deoras (P. J.) & Ranade (D. R.). **Life-history of the common Indian House-fly** *Musca domestica nebulo* **Fabricius.**—*Indian J. Ent.* **19** pt. 1 pp. 15–22, 7 figs., 14 refs. New Delhi, 1957.

Descriptions are given of the various stages of *Musca domestica nebulo* F., which was reared in the laboratory at Poona for studies of its life-history, by a technique previously described [*R.A.E.*, B **44** 14]. Mating took place about 24 hours after emergence, and oviposition began 3–6 days later. Females laid a maximum of about 600 eggs each, in batches of 25–95, in dark corners. Both oviposition and hatching took place mainly in the early morning or late evening. The egg stage usually lasted not more than 24 hours. It was sometimes completed in 8–12 hours at 77–97°F., but 2–3 days were needed at 59–68°F. At optimum temperature and relative humidity for larval development (30°C. [86°F.] and 75 per cent.), the three instars lasted, respectively, about 20 hours, 24 hours and 4–10 days. The

pupal stage usually lasted 3–8 days, but emergence, which usually took place in the early morning, was delayed by 30 days at 50°F., and the pupae died at 0°C. [32°F.]. Feeding began about three hours after emergence, and the adults lived about 28–30 days in the hot months and up to 70 in the cold ones. They rested for preference on hanging threads facing the light.

MacLeod (J.). **The Estimation of Numbers of mobile Insects from low-incidence Recapture Data.**—*Trans. R. ent. Soc. Lond.* **110** pt. 13 pp. 363–392, 27 refs. London, 1958.

The following is largely the author's summary. The three major approaches to the analysis of data from multiple releases and recaptures that are applicable to experiments with insects are the method due to Fisher and those due to Jackson [*R.A.E.*, B **28** 140; **39** 97], all of which utilise the results of a series of several successive releases, and Bailey's triple-catch method, which relies on two catches followed by releases and a third catch for recovery only. These methods are described, and their common relation to the Lincoln index, which is also based on the assumption that the proportion of marked individuals in a population sample is the same as that of the total number of marked individuals released to the total population [*cf.* **28** 140], but which requires only one release and one recapture, is examined. Some difficulties in applying the release-recapture technique to the estimation of numbers of mixed populations of mobile insects are outlined. None of the three analysis methods is suitable for interpreting release-recapture data in cases where the loss-rate of marked insects over a subsequent run of time-intervals cannot be represented by a constant factor, and where the incidence of recaptures is generally low, with many blank days. The weaknesses of the three analysis methods under these circumstances are illustrated by an example of their application to data derived from an experiment with blowflies.

In work on wild blowfly populations, it was found that, because of the difficulty of fully identifying all the species in samples when these have to be released subsequently, a single release was preferable to serial releases, subsequent serial samples being retained for identification. Information on loss-rate, normally supplied by successive releases, was more satisfactorily obtained by independent experiments, since it did not appear to be a regular rate. Simple methods, evolved for blowfly studies, are described for pooling results from single or serial releases where the recoveries are poor, so as to extract an estimate of numbers. In these, the mortality is estimated from laboratory controls, and the emigration rate beyond the zone of influence of the traps is calculated from independent experiments on the dispersal rate of a concentration of marked flies.

Fryer (G.). **Lunar Rhythm of Emergence, differential Behaviour of the Sexes, and other Phenomena in the African Midge,** *Chironomus brevibucca* **(Kieff.).**—*Bull. ent. Res.* **50** pt. 1 pp. 1–8, 2 graphs, 6 refs. London, 1959.

The following is substantially the author's summary. Larvae of *Chironomus brevibucca* (Kieff.) are abundant in the littoral zone of Lake Bangweulu, Northern Rhodesia, where, at certain times of the year, adults emerge in vast numbers shortly after the appearance of the full moon. Attracted by light, they fly to houses and alight on the screens, which they cover in masses at peak periods of emergence. They have not been seen at other phases of the lunar cycle, and it is concluded that adult life lasts not

more than ten days and usually much less. The adults are inactive by day. The sexes tend to settle in different situations. There was a marked preponderance of females (4·68 : 1) on the gauze screens on the day following a night's swarming, but males predominated (2·92 : 1) on several adjoining whitewashed walls. Females outnumbered males on grasses near the lake margin. When the screening of a house was diffusely illuminated, adults were attracted to it during the early hours of darkness. The first to arrive were almost invariably males, but females followed rapidly, and finally constituted the bulk of the population. On one evening, the percentage of males was 95·4 at 6.44 p.m. and 29·5 at 9.45 p.m. The percentage reaches a minimum between 7 and 8 p.m. and thereafter shows some rise, probably due to a secondary influx of males that have been resting during the day, not newly emerged ones. The condition of the antennae seems to give an indication of the age of males during the early part of adult life.

Miscellaneous observations on swarming and mass movement are recorded. A recent hypothesis put forward by P. Korringa, which seeks to explain the periodic swarming of shallow-water polychaetes just after the time of full moon as the result of an additive effect of exposure to nocturnal illumination on the maturation of organisms that are not subjected to sunlight by day, is examined and shown to be applicable to *C. brevibucca*.

Kettle (D. S.), Parish (R. H.) & Parish (J.). **Further Observations on the Persistence of Larvicides against *Culicoides* and a Discussion on the Interpretation of Population Changes in the untreated Plots.**—*Bull. ent. Res.* **50** pt. 1 pp. 63–80, 4 graphs, 6 refs. London, 1959.

The following is almost entirely based on the authors' summary. Further observations were made in the first three months of 1957 on the persistence, after three years, of larvicides applied to plots 10 yards square on Soutra Hill, near Edinburgh, to control larvae of *Culicoides impunctatus* Goetgh. [*cf. R.A.E.*, B **44** 198; **45** 128]. Evidence is produced that fluctuations in larval population observed in the nine untreated control plots were due, not to delayed hatching of eggs (which, if it occurs, is of minor importance) or to change in sampling technique or to the application of insecticide to neighbouring plots, but to the response of the larvae to an oscillating factor (or factors) in the breeding site, such as the level of soil water. It follows that changes in populations of untreated larvae must be taken into account when the degree of control achieved by treatments is being assessed, especially when the larval population is declining.

In 1957, complete control was still being given by 12, 50 and 200 mg. p.p′DDT per sq. ft. applied as a water-miscible concentrate or dust and 50 and 200 mg. applied as a wettable powder, which at 12 mg. per sq. ft. gave reductions of 75 per cent. in one test and 22 per cent. in another. Only one of seven treatments with γ BHC (wettable powder at 50 mg. per sq. ft.) gave complete control, and one treatment (wettable powder at 12 mg. per sq. ft.) was completely ineffective. On all plots taken together, DDT and γ BHC achieved 93 and 55 per cent. control, respectively. The lowest dosages of dieldrin (3 mg. per sq. ft.) and chlordane (6 mg. per sq. ft.) had begun to lose their larvicidal power, the control effected by them having declined from 76 to 53 and from 67 to 29 per cent., respectively, but there was practically no change in the effectiveness of dieldrin at 6 mg. per sq. ft. and that of the higher dosages (12 and 25 mg. dieldrin and 12, 25 and 50 mg. chlordane per sq. ft.) had improved. Dieldrin at both these dosages and chlordane at the highest gave complete control.

Treatments in the tests on the influence of spray volume on effectiveness [**45** 128], in their second year, showed an increase in activity. This was

most marked in the treatments at the lower rate (25 mg. p,p'DDT per sq. ft.), which were completely ineffective in the first year but now gave complete control in five out of six trials and 97 per cent. control in the other. Improvement in the treatments at 50 mg. per sq. ft. was less (from 43 to 83 per cent.), owing almost entirely to the complete failure of one treatment (10 gal. per acre). It is confirmed that spray volume in itself is unimportant, providing the coverage is adequate.

PARR (H. C. M.). **Studies on** *Stomoxys calcitrans* **(L.) in Uganda, East Africa. I. A Method of rearing large Numbers of** *Stomoxys calcitrans*. —*Bull. ent. Res.* **50** pt. 1 pp. 165–169, 3 refs. London, 1959.

Flies of the genus *Stomoxys* can be found throughout Uganda, particularly during and immediately after the rainy periods, and they have a considerable adverse effect on milk yield and weight gains of cattle in many areas, and possibly also spread trypanosomiasis mechanically [*cf. R.A.E.*, B **22** 236–237; **25** 51; **44** 116]. The author identified only two species, *S. calcitrans* (L.) and *S. nigra* Macq., the former predominating. In order to study its behaviour and life-history in detail, a method of breeding it in large numbers under East African conditions was evolved. Oviposition cages, of about 6 cu. ft. content, were made with angle-iron frames, plywood flooring and sides mainly of small-mesh cotton sandfly netting. They were kept under normal atmospheric conditions in a laboratory in good light. Food consisting of 0·2 per cent. citrated bullocks' blood on absorbent pads hung from the roof was supplied twice daily. A mixture of 9 oz. dried cow dung, 5 oz. dried blood granules and 1 oz. sugar provided an extremely satisfactory oviposition and rearing medium when exposed, after fermentation in covered containers, in shallow pans on 4-in. high platforms in the oviposition cages. If the population of each cage was maintained at about 1,200 flies, daily removal of the pans and division of their contents evenly between 20 1-lb. or 10 2-lb. jars produced about 200 or 400 pupae per jar, respectively; these were the maximum numbers that could be produced without reduction in the size of the pupae due to overcrowding and under-nourishment of the older larvae. The jars were filled with the rearing medium to within 1 inch of the top, covered with a loose-weave cotton cloth, and stored in complete darkness in a windowless constant-temperature and constant-humidity room of concrete coated on the inside with waterproof bituminous paint. Temperature and relative humidity were maintained at 90 $\pm$ 1°F. and 90 $\pm$2 per cent., respectively. Pupation occurred after about ten days, on or near the surface of the medium, and the pupae were put on trays in sandfly-netting emergence cages. The newly emerged adults were left in these in the constant-temperature room for 3–4 hours before being transferred to an oviposition cage.

SQUIRE (F. A.). **Infectibility of Tsetse Flies,** *Glossina palpalis* **(R.-D.) and** *G. tachinoides* **Westw. with** *Trypanosoma vivax*.—*Bull. ent. Res.* **50** pt. 1 pp. 183–189, 6 refs. London, 1959.

The following is largely based on the author's summary. Observations were made in 1954 at Dorimon, in north-western Ghana, during the hot months of March and April, on the infectibility with *Trypanosoma vivax* of *Glossina palpalis* (R.-D.) and *G. tachinoides* Westw. Pupae of these species were obtained from the banks of the Black Volta, where shade temperatures ranged from 70 to 98°F. [*cf. R.A.E.*, B **37** 136]. The flies that emerged from them were kept singly, without having had opportunity for mating, in

glass tubes (6 in. by 1 in.) in the laboratory at a temperature and relative humidity that varied from 85 to 95°F. and from 60 to 80 per cent., respectively. They were fed, generally more than four times and sometimes more than 20 times, on goats that had been shown by wet smears to have numerous trypanosomes in the blood at the time of feeding.

The flies were dissected at ages varying between 7 and 45 days, and the percentages showing infection of the labrum or hypopharynx or both, and (in brackets) of the labrum, alone or with the hypopharynx, were 56·1 (37·4) for all flies, 72·2 (27·8) for males and 34·6 (15·4) for females of *G. palpalis*, and 68·4 (68·4) for males and 56·8 (40·9) for females of *G. tachinoides*. The percentages of flies in which trypanosomes had disappeared from the labrum after invading both it and the hypopharynx were 48·8 for all flies, 66·7 and 62·5 for males and females of *G. palpalis* and 0 and 43·8 for those of *G. tachinoides*. The latter species, therefore, seems to be the more tenacious of infection. Early infection was the rule, but late infections occurred. Since 47 flies remained uninfected out of 107 that had had an average of 10·6 infective meals each, some appear to be uninfectible. The percentage of flies less than 14 days old that were infected was 67·8, which is higher than that found when flies of all ages were included, so that there appears on balance a loss rather than a gain in infection rate as the fly population ages. This agrees with an earlier report of at most a slight increase in infection rate [**23** 228] after repeated feeds on an infected animal but differs from a more recent one indicating a higher rate in older age groups [**40** 4]. Trypanosome colonies in the labrum seemed to suffer no adverse effect when the infected flies were fed on goats known to be infected but not showing trypanosomes in the blood at the time of feeding or on a spurwing goose (*Plectopterus gambensis*).

Teesdale (C.). **Observations on the Mosquito Fauna of Mombasa.**—*Bull. ent. Res.* **50** pt. 1 pp. 191–208, 4 graphs, 13 refs. London, 1959.

The following is largely based on the author's summary. Records are given of some 75 species of mosquitos taken on Mombasa Island in 1943–44 and on the adjacent mainland of Kenya in 1949–52 by daytime sweeping with hand-nets in the bush (any situations outside a village compound, including those in cultivation or plantations), in window-trap catches, in diurnal catches of females coming to bite in the bush and in 24-hour catches of females biting inside and outside houses and on platforms in a mango tree. All catches of biting females were on human bait. The mosquitos taken included six species of *Anopheles*, one represented by three varieties, but no species of this genus was very common. The habits of the species most frequently taken are discussed in some detail, except those of *Aëdes aegypti* (L.), which have been dealt with elsewhere [*R.A.E.*, B **44** 5]. *Culex pipiens fatigans* Wied. was the most abundant mosquito [*cf.* **47** 22]. It occurred in large numbers in biting catches, net catches and window-trap catches. In 24-hour catches, most biting occurred after midnight, but activity in the window traps was greatest between 6 p.m. and 9 p.m. *Aëdes simpsoni* (Theo.), an " outdoor " mosquito, was not taken in window traps and practically never in houses. Net catches at Mombasa showed two peaks of adult abundance, in May and June and in September, but at Kwale, about 20 miles to the south, there was only one peak of larval production in banana leaf axils [*cf.* **45** 123–124], in July. The 24-hour catches confirmed earlier findings that it bites almost solely during daylight [*cf.* **34** 28; **43** 92]. It was in evidence throughout the year, though comparatively scarce from January to March. *A. pembaensis* (Theo.) occurred throughout the year with little seasonal variation. This is thought to be connected with its

habit of breeding in crab-holes [**46** 150]. It was very common in the outside biting and net catches and was often found in fair numbers in houses [*cf.* **46** 129], especially when these were near the foreshore where mangroves (*Avicennia*) were growing. Window-trap catches show that it is mostly, though not exclusively, active at night. The greatest numbers left houses between 6 p.m. and 9 p.m. and between 7 a.m. and 8 a.m. The biting rhythm showed peaks at about 7 a.m. and 7 p.m. in the open, but biting continued irregularly almost thoughout the 24 hours in houses, possibly because light intensity there was reduced during the day. *Anopheles gambiae* Giles and *A. funestus* Giles were scarce in net catches, and window-trap catches indicated that their activity was greatest at night, although some also occurred during the day. The 24-hour catches showed that *A. gambiae* fed mostly just before dawn, though there was some biting from midnight onwards. *A. funestus* appeared suddenly and in fair numbers in window traps but was absent for much of the year and was hardly ever taken in the 24-hour catches.

Senevet (G.), Andarelli (L.), Duzer (A.) & Lieutaud (A.). *Anopheles multicolor* **dans le Tell algérien. III. Une station dans la plaine du Chélif.**—*Arch. Inst. Pasteur Algérie* **34** no. 4 pp. 550–551, 3 refs. Algiers, 1956. **Gîtes à** *Anopheles multicolor* **Cambouliu dans le Tell algérien. IV.**—*Op. cit.* **35** no. 3 pp. 296–300, 1 map, 3 refs. 1957.

In the first of these papers, *Anopheles multicolor* Camb., which had recently been found to occur in the Ténès district of Algeria [*R.A.E.*, B **44** 46, 124], is additionally recorded from the neighbourhood of Relizane, at the foot of the hills bordering the plain of the Cheliff on the south, where an immature larva was taken in 1955 and adults in 1956.

In the second paper, further new records are given, which extend the known distribution in the plain of the Cheliff and show the species to be present near Arzew, some 60 miles to the west. Three types of breeding places are distinguished for *A. multicolor* in northern Algeria. These are deep, narrow holes without vegetation and rather pebbly pools in almost dry water-courses in the hills, and holes near the salt-works. The salinity of the newly discovered breeding places ranged from 14·4 g. to 174 g. sodium chloride per litre, but water with about 14 g. had many more larvae than water with more than 20 g. No larvae of *A. multicolor* were found in a hole with 5·25 g. per litre. The pH varied from 5·5 to 7. Adults were taken in August, October and November, larvae in October, November and late January and pupae in October and November. It is tentatively concluded that the season of activity probably extends from August to the end of January, that the breeding season is autumn, when at least two generations are produced, and that the rest of the year is passed in the adult stage.

Papers noticed by Title only.

Evens (F.), Meyus (M.), Pierquin (L.) & Niemegeers (C.). **Dispersion géographique des glossines** [*Glossina* spp.] **au Congo belge et au Ruanda-Urundi.**—*Mém. in 8°. Acad. R. Sci. colon., Cl. Sci. nat.* (N.S.) **6** fasc. 2, 41 pp., 2 maps (1 fldg.), 24 refs. Brussels, 1957.

Leeson (H. S.). **An annotated Catalogue of the Culicine Mosquitoes of the Federation of Rhodesia and Nyasaland and neighbouring Countries, together with Locality Records for Southern Rhodesia.**—*Trans. R. ent. Soc. Lond.* **110** pt. 2 pp. 21–51, 1 map, 45 refs. London, 1958.

Whitehead (F. E.). **Flight Range of Rice Field Mosquitoes.**—*Bull. Ark. agric. Exp. Sta.* no. 590, 7 pp., 2 refs. Fayetteville, Ark., 1957.

Data on the flight range of rice-field mosquitos (*Psorophora confinnis* (Lynch Arrib.) and *P. discolor* (Coq.)) in Arkansas [*cf. R.A.E.*, B **32** 157–158; **44** 21] were obtained from 21 New Jersey light-traps operated three nights a week from 25th June to 9th August 1955 in a rice-growing area and at intervals of about half a mile or a mile for 12 miles in a line at right angles to the edge of it. Less than 3 per cent. of the 943,070 mosquitos trapped were taken in the 11 traps situated four miles or more from the rice-fields, and only about 10 per cent. in those situated further than 1·7 miles. Some of the mosquitos taken in the more distant traps doubtless originated locally.

Davis (H. G.) & James (M. T.). **Black Flies attracted to Meat Bait (Diptera: Simuliidae).**—*Proc. ent. Soc. Wash.* **59** no. 5 pp. 243–244. Washington, D. C., 1957.

Considerable numbers of *Simulium vittatum* Zett. were taken during the summers of 1954 and 1955 in the State of Washington in traps containing ground beef with ample quantities of tallow on white paper towelling and exposed in six stations, each representing a different ecological habitat. The moisture-retaining qualities of the ground beef were an advantage, and meat that had been allowed to putrefy seemed more attractive than freshly prepared meat.

Miles (J. W.) & Pearce (G. W.). **Rapid Method for Measurement of Rate of Sorption of DDT by Mud Surfaces.**—*Science* **126** no. 3265 pp. 169–170, 1 graph, 3 refs. Lancaster, Pa., 1957.

Hitherto, all measurements of loss of insecticidal activity of DDT and related compounds from mud surfaces [*cf. R.A.E.*, B **46** 123–124, etc.] have been based on biological methods supplemented by chemical analyses. Such methods are slow and the results difficult to evaluate. A rapid method of assessment has now been evolved, based on the measurement of the loss of radioactivity from surfaces dusted with ^{14}C-labelled DDT. Because the ^{14}C-labelled compound migrates to a depth only slightly beneath the surface, the weak β-rays are shielded, so that it is possible to follow the loss of insecticide from the surface by measuring the loss in radioactivity. To study the method, samples of mud from three areas were dried, ground, sieved and made into a thick paste, which was dried in moulds. The resulting mud blocks were kept in desiccators, one-third in a dry atmosphere and one-third each at relative humidities of 47 and 94 per cent. for several days. A homogeneous mixture was prepared, by dissolving 990 mg. pure p,p′DDT and 9·8 mg. radioactive p.p′DDT (specific activity 0·48 mc. per g.) in carbon tetrachloride, evaporating the solvent, drying the residue over silica gel and grinding it to a fine powder. Each mud block was then dusted with the powder, receiving about 1 mg. DDT particles ranging in diameter from 1 to 25 μ, deposited from a stream of nitrogen. The average radioactivity of each block immediately after dusting was 4,220 counts per minute. The blocks were returned to the humidity-controlled desiccators, and their radioactivity recounted at intervals of 1–5 days. Radioactivity decreased on an average by 15·2, 7·6 and 4·2 per cent. in 24 hours in samples kept in the dry atmosphere and at 47 and 94 per cent. relative humidity, respectively. Over the observation period of two weeks, the rate of loss was about the

same for the different types of mud kept at the same relative humidity. It was about 15, 55 and more than 70 per cent. at 94 and 47 per cent. relative humidity and in a dry atmosphere, respectively. When samples were transferred from the drier atmospheres to 94 per cent. relative humidity on the tenth day, their radioactivity rose again slightly. After the treated blocks had stood for about 30 days, successive layers 0·5 mm. thick were scraped off and their DDT content ascertained by the Schechter-Haller method [**35** 196]. The percentages of DDT in the top, second and third layers were found to be 98, 1·4 and 0·6 in samples maintained at 94 per cent. relative humidity, 90·7, 7·1 and 2·2 in samples kept at 47 per cent. relative humidity and about 82, 15 and 3 in samples kept in the dry atmosphere. No DDT was found at a greater depth than 1·5 mm.

Proceedings of the Tenth International Congress of Entomology, Montreal, August 17–25, 1956. Section on Physiology and Toxicology.—*Proc. 10th int. Congr. Ent.* **2** pp. 3–393. Ottawa, 1958.

The following are abstracts of selected papers containing hitherto unpublished information of which the text is printed in full in this section [*cf. R.A.E.*, B **47** 74].

Smallman (B. N.). **The physiological Basis for the Mode of Action of Organophosphorus Insecticides,** pp. 5–12, 4 figs., 27 refs. The following is virtually the author's abstract. The physiological basis for the hypothesis that the organophosphorus compounds exert their insecticidal action by inhibition of cholinesterase is examined. The elemental basis for the hypothesis requires the demonstration of acetylcholine, acetylcholinesterase and choline acetylase in insects. Current evidence for these elements in insects is reviewed and its adequacy discussed. Recent findings on the acetylcholine content of insect nervous tissue (heads of house-flies [*Musca domestica* L.] and *Lucilia sericata* (Mg.)) are presented. Evidence that acetylcholine and the mechanisms for its metabolism occur in insects does not establish its functional significance or resolve the anomaly of the insensitivity of insects to exogenous acetylcholine. These problems are discussed in the light of recent evidence for the release of acetylcholine on stimulation of insect nerves, and the demonstration that the insect nervous system is impervious to applied acetylcholine. Finally, evidence is presented to show that acetylcholine accumulates in the nervous tissue of insects after inhibition of cholinesterase by organophosphorus compounds.

Metcalf (R. L.), Fukuto (T. R.) & March (R. B.). **Mechanisms of Action of Anticholinesterase Insecticides,** pp. 13–18, 14 refs. The following is based on the authors' abstract. The reactions between cholinesterase enzymes and phosphorus and carbamate insecticides are simple bimolecular reactions leading in the case of the former to phosphorylation of the enzymes and in the latter to the blocking of the active site by a relatively stable competitor. Thus, maximum activity in the phosphate compounds is a result of pronounced instability at the primary ester bond, while for the carbamates pronounced stability at the primary ester bond is essential. In addition to the stability of the molecule, its size, shape and charge are of importance in establishing its toxic action. The relation of these factors to insecticidal action was critically evaluated for a series of phenyl N-methyl carbamates, including the parent compound and compounds containing various substituents in the phenyl radicle. Good agreement was found between predicted values of toxicity, as deduced from the influence of substituent groups on the reactivity at the primary ester bond and on the degree of fit to the enzyme surface, and the experimentally determined LD50 values for the house-fly [*Musca domestica* L.] and a thrips and

inhibition of fly-head cholinesterase. Highly charged molecules, although excellent enzyme inhibitors, are of inferior activity as contact toxicants, apparently because of their inability to penetrate to the site of action. Similar approaches were made to the problems of explaining the toxic action of the phosphorothionate and phosphorodithioate compounds, such as parathion and malathion, which are highly stable and relatively inactive as cholinesterase inhibitors. These have been shown to be oxidised in plant and animal tissues to compounds of greater instability that are able to phosphorylate the cholinesterase enzymes and are consequently responsible for the ultimate toxic action.

Hagley (E. A. C.) & Morrison (F. O.). **The synergistic Action of certain Chemicals used in Combination with DDT,** pp. 175–185, 1 graph, 47 refs. The following is substantially the authors' abstract. Four methylenedioxyphenyl compounds (piperonyl cyclonene, piperonyl butoxide, n-propyl isome (di-n-propyl 6,7-methylenedioxy-3-methyl-1,2,3,4-tetrahydronaphthalene-1, 2-dicarboxylate) and sulfoxide [1,2-methylenedioxy-4-(2-(octylsulphinyl)-propyl)benzene], di(p-chlorophenyl)chloromethane, di(p-chlorophenyl)-methyl-carbinol (DMC) and di(p-chlorophenyl)-ethinyl-carbinol were tested for synergistic action with DDT when applied topically to adult house-flies [*Musca domestica* L.] of two strains. The methylenedioxyphenyl compounds had no synergistic action, but the others were all effective in increasing the lethal action of DDT irrespective of fly strain. Increasing the proportion of synergist to DDT from 1:1 to 10:1 increased the effect. Studies using DDT labelled with ^{14}C revealed no increase in DDT penetration due to the synergist. When either DDT or synergist was applied in advance of the other, or when applications were made to different loci on the body, the synergistic effect was the same, but mixtures applied directly to the brain tissues were little more effective than DDT alone. When the synergist was applied to the proboscis and the DDT to the thorax after the cervical region had been tightly ligatured, the effect of the ligature in reducing mortality was still evident, but was not so marked as with DDT alone applied to the thorax.

Levinson (Z. H.). **Chemicals affecting the preimaginal Stages of the Housefly. V. Vapour Toxicity of the Dichlorobenzenes to Housefly Pupae.**—*Riv. Parassit.* **16** no. 4 pp. 253–256, 2 figs., 4 refs. Rome, 1955. (With a Summary in Italian.) **VI. Further Tests with highly chlorinated aliphatic and alicyclic Compounds.**—*Op. cit.* **17** no. 1 pp. 51–57, 1 graph, 5 refs. 1956. (With a Summary in Italian.)

In the experiments described in the first of these papers, which form part of a series [*cf. R.A.E.*, B **44** 203], the vapour toxicity to pupae of *Musca domestica vicina* Macq. of p-dichlorobenzene, which has been used successfully as a soil fumigant against house-fly pupae [*cf.* **25** 109–110; **31** 28], was compared with that of m- and o-dichlorobenzene. Third-instar larvae were kept at about 30°C. [86°F.] in a sealed chamber made of two petri-dish covers, and groups of pupae were removed after 24 hours and exposed in a sealed container at the same temperature to an atmosphere saturated with the vapour of one of the compounds. They were then transferred to beakers and kept at 30°C. until adult emergence was completed. Percentage emergence was about 46, 15 and 2 from pupae exposed for three hours to the three compounds, respectively, and 94 among controls. There was no emergence after exposure to any of the compounds for ten hours.

The experiments described in the second paper were carried out in view of the high toxicity of the volatile octachloropropane in the vapour phase to

house-fly larvae and pupae and the contact toxicity for third-instar larvae of the comparatively non-volatile decachlorobutane [*cf.* **44** 204]. Decachlorobutane was compared with 12 related highly chlorinated compounds in the breeding medium against larvae of *M. d. vicina*. Solutions of the compounds in acetone were added at 1:25 to distilled water containing a fungistatic agent, and an equal weight of sieved wheat bran was stirred in. The final concentrations of the compounds in the medium ranged from 50 to 5,000 parts per million. A suspension of stock bacterial flora was added before each test, and second-instar larvae were used. Hexachlorobutadiene caused almost complete mortality within 48 hours at 100 p.p.m. Under identical test conditions, decachlorobutane caused complete mortality only at 500 p.p.m. and no mortality at 100 p.p.m., and pentachlorobutadiene and hexachlorocyclopentenone gave complete and almost complete kill, respectively, at 1,000 p.p.m. but comparatively low mortality at 500 p.p.m. Hexachlorobutane, octachloropentadiene, nonachloropentene and octachlorocyclopentene were only very slightly toxic and the five chlorinated C_6-compounds non-toxic. It was apparent that the presence of ethylenic linkages in the molecule enhanced toxicity. Determination of the evaporation rates of the tested compounds indicated a correlation between toxicity and volatility. No third-instar larvae exposed for 15 hours or pupae exposed for 24 hours to an atmosphere saturated with hexachlorocyclopentenone, hexachlorobutadiene or pentachlorobutadiene vapour gave rise to adults, but whereas hexachlorocyclopentenone gave 98 per cent. mortality of larvae exposed for three hours, the other two compounds caused very low mortality with this exposure.

Ascher (K. R. S.). **Houseflies in Israel. I. A Resistance Survey in rural Areas.**—*Riv. Parassit.* **18** no. 2 pp. 113–122, 5 figs., 18 refs. Rome, 1957. (With a Summary in Italian.)

Gratz (N. G.), Rosen (P.) & Ascher (K. R. S.). **II. A preliminary Survey of Species breeding in rural Areas.**—*T. c.* pp. 123–127, 7 refs. (With a Summary in Italian.)

In the second paper, the results are given of determinations of flies of the genus *Musca* that occur in rural areas in Israel, made in connection with an investigation of insecticide resistance. Samples of medium from representative breeding sites (cow and chicken manure, garbage and compost) were collected, and males that emerged from 39 of them were identified. Of the 11 species and subspecies of *Musca* that occur in Israel, of which a list is given, only three were found. *M. domestica vicina* Macq. predominated in all collections, irrespective of area or season. The percentage of *M. d. nebulo* F. varied from 0 to 43 and was highest in the southern coastal area. *M. sorbens* Wied. was represented by six examples only.

The results of the survey of resistance to DDT and γ BHC in 42 samples that were collected in the summer and early autumn of 1955 are given in the first paper. F_1 females 2–5 days old were tested by Kocher's short-duration tarsal contact method [*R.A.E.*, B **42** 193], in which the flies are exposed for ten minutes to deposits left in glass jars by the evaporation of acetone solutions. Six concentrations of each compound were used to determine the LC50, and 100 flies from each locality were tested in batches of ten at each level. Flies of a collection designated the " B " strain from Brur-Chajil in the Southern district were the most susceptible to both compounds, with LC50's of 35 mg. DDT and 7 mg. γ BHC per sq. metre, and this was adopted as a reference strain. Flies from the Northern, Haifa and Central districts in general showed high or medium resistance, the LC50's ranging

from 70 to over 1,000 mg. per sq. metre for DDT and from 15 to 300 mg. for γ BHC, and the use of these compounds would be warranted there only in isolated localities, but around Tel-Aviv and in the Southern district, there was often little or no resistance. No correlation was noted between the presence or absence of *M. d. nebulo* and the level of resistance to DDT or γ BHC.

Labrecque (G. C.) & Wilson (H. G.). **House Fly Resistance to Organophosphorus Compounds.**—*Agric. Chem.* **12** no. 9 pp. 46–47, 147, 149, 4 figs., 2 refs. Baltimore, Md., 1957.

Baits poisoned with malathion and other organic phosphorus compounds have been used for several years against house-flies (*Musca domestica* L.) on poultry and dairy farms in central Florida, and flies from the treated buildings have often shown 5–20 times the normal resistance to malathion and Dipterex [dimethyl 2,2,2-trichloro-1-hydroxyethylphosphonate], even though control was still satisfactory. Failure of malathion to give adequate control in poultry houses at Pine Castle and Tampa was reported in the autumn of 1956 and spring of 1957, and resistance in these areas was therefore investigated. Flies reared from larvae collected at a Pine Castle poultry farm (Grothe) on which malathion had been used for 2½ years as a larvicide and also in sprays and baits against the adults and was no longer effective were tested by three methods in comparison with a non-resistant (Orlando) colony for susceptibility to malathion, Dipterex, technical Dow ET-57 [O,O-dimethyl O-2,4,5-trichlorophenyl phosphorothioate] and parathion. Further tests were made with the F_1 and F_2 generations of a colony established from the survivors and some untreated flies. A strain from Tampa was tested by one method after it had been reared through four generations without selection. All flies used were females. Contact tests were made by atomising 0·25 ml. kerosene solution of insecticide at a pressure of 1 lb. per sq. in. into the mouth of a wind tunnel 4 in. in diameter, through which a column of air was drawn at 4 miles per hour. The flies were exposed in the centre of the tunnel in a cylindrical screen cage. For bait tests, acetone solutions of the toxicants were added to sugar, the solvent was evaporated and screen cages containing the flies were placed on samples of the bait in petri dishes and left for 14 hours. The effect of prolonged contact with deposits was tested by confining 20 flies for periods ranging from 15 minutes to 24 hours on plywood panels treated with 100 mg. Dipterex or 500 mg. malathion per sq. ft. Mortality counts were made 24 hours after the beginning of the exposure period. When a 24-hour exposure failed to cause complete mortality, exposure was continued for 72 hours.

Both field-collected strains showed more resistance than the Orlando colony to all the insecticides. On the basis of the median lethal concentration (LC50), the Grothe strain was about 37 times as resistant as the Orlando strain to contact sprays of malathion, but only slightly resistant to Dipterex, ET-57 and parathion. After two generations of partial selection, it was more than 50 times as resistant to malathion, more than four times as resistant to Dipterex, over 13 times as resistant to ET-57 and nearly four times as resistant to parathion as the Orlando strain. Resistance was more than 100-fold to malathion and about sevenfold to Dipterex in the bait tests, which involve acceptance as well as toxicity. Flies of this strain showed about 40-fold resistance to malathion deposits on the basis of the time of exposure needed to produce 50 per cent. mortality (LT50) and about 70-fold on the basis of the LT90. The Tampa strain showed 23-fold resistance to malathion as a contact spray, but little resistance to Dipterex.

DAVIDSON (G.). **Insecticide Resistance in** *Anopheles sundaicus*.—*Nature* **180** no. 4598 pp. 1333–1335, 5 refs. London, 1957.

A thriving colony of a strain (R) of *Anopheles sundaicus* (Rdnw.), resistant to DDT, was established in London from eggs sent in July 1956 from Java, where such resistance has been reported in several localities [*R.A.E.*, B **44** 163; **46** 214]. Repeated attempts to send eggs of a susceptible strain from Java were unsuccessful, but a susceptible strain (S) was established with difficulty from Malayan material. The susceptibilities of the two strains to a range of insecticides were compared by the standard Busvine (WHO) method [**46** 203, etc.], in which mosquitos are exposed for one hour to filter papers impregnated with various concentrations of insecticides in oil and mortalities are recorded 24 hours later. The median lethal percentage concentrations (LC50's) of DDT, dieldrin and γ BHC for the R and (in brackets) S strain were found to be $>$ 4 (0·3), 0·038 (0·032) and 0·006 (0·003). These concentrations are lower than those recorded in the field in Java [**46** 203], because blood-fed, semi-gravid and gravid females were used there, whereas the laboratory tests were made with the more susceptible unfed females and males. The percentage mortalities caused in the R and (in brackets) the S strain by exposure to 1 per cent. methoxy-DDT (methoxychlor), 2 per cent. DDD and 4 per cent. ethyl-DDD (1,1-di(p-ethylphenyl)-2,2-dichloroethane) were 24 (89), 3 (100) and 16 (100), respectively. Thus, as in DDT-resistant strains of other insects, cross-resistance extended to closely related compounds but not to the cyclodiene compounds or BHC. Mosquitos of the S strain exposed to 0·1 per cent. DDT and of the R strain exposed to 4 per cent. DDT for 2 hours showed 50 and 58 per cent. mortality, respectively, so that an approximately 40-fold resistance was indicated [*cf.* **44** 163]. This was resistance of a much lower order than that of *A. gambiae* Giles to dieldrin [**45** 68].

Reciprocal crosses between the S and R strains produced hybrids only slightly more resistant to DDT than the susceptible strain. It was therefore not possible to choose a discriminating dosage that would kill S mosquitos and not hybrids, as was done for dieldrin-resistant *A. gambiae* [**45** 69], but it was possible to choose one (2·5 per cent.) that would kill almost all S and hybrid but very few R mosquitos. The hybrids of *A. sundaicus* readily interbred. Mortality in the F_2 generations exposed to the discriminating dosage was about 75 per cent., which indicated simple Mendelian inheritance, and back-crossing the hybrids with the parent strains confirmed this. About 50 and nearly 100 per cent. of the offspring of the back-crosses to the resistant and susceptible parents, respectively, were killed by the discriminating dosage, so that inheritance of resistance by a simple monofactorial mechanism was indicated [*cf.* **47** 72]. Resistance being virtually recessive, the heterozygote resembles the susceptible homozygote. The offspring are therefore either resistant or susceptible, whereas in *A. gambiae* resistant to dieldrin and BHC, three phenotypes were found [**45** 68, 69]. It is almost certain that the heterozygote *A. sundaicus* would be killed by field dosages of DDT, and this may explain why DDT-resistance in Anophelines has always been much slower to appear in the field than was resistance to dieldrin and BHC in *A. gambiae*, in which the hybrids, being significantly resistant, almost certainly survive. The type of resistance to DDT shown by *A. sundaicus* would probably not be detected when homozygote resistant individuals were few, because hybrids cannot be identified in practice. The offspring of a homozygote resistant female, caught in the field after fertilisation by an unknown male, would be either all resistant, half resistant and half hybrid or all hybrid. In the last case, all would succumb to the discriminating dose, and so might be thought to be derived from two susceptible parents. An F_2 generation derived from them, however, would

consist of 25 per cent. resistant, 50 per cent. hybrid and 25 per cent. susceptible individuals, and the resistant ones would be detectable. In field observations, therefore, the presence of many survivors of a discriminating dose would indicate resistance, and the presence of a few would give rise to a suspicion of it, to be followed by the rearing and testing of progeny from them, and if possible, the rearing and testing of a second generation.

PLAPP (F. W.) & CASIDA (J. E.). **Bovine Metabolism of Organophosphorus Insecticides. Metabolic Fate of O,O-Dimethyl O-(2,4,5-trichlorophenyl) Phosphorothioate in Rats and a Cow.**—*J. agric. Fd Chem.* **6** no. 9 pp. 662–667, 5 figs., 24 refs. Easton, Pa., 1958.

The following is based on the authors' summary. Experiments are described showing that O,O-dimethyl O-2,4,5-trichlorophenyl phosphorothioate is hydrolysed at the methyl-phosphate and the phenyl-phosphate bond *in vitro* by treatment with alkali or juice from cattle rumens and *in vivo* in rats, a cow and house-flies [*Musca domestica* L.]. Similar cleavage was undergone by its oxygen analogue, O,O-dimethyl O-2,4,5-trichlorophenyl phosphate. The excretory metabolites of the phosphorothioate and three derivatives of it in rats were ascertained; detoxification and excretion of the metabolites were slower in the cow than in rats, but the metabolic pathway was the same.

AHMED (M. K.), CASIDA (J. E.) & NICHOLS (R. E.). **Bovine Metabolism of Organophosphorus Insecticides: Significance of Rumen Fluid with particular Reference to Parathion.**—*J. agric. Fd Chem.* **6** no. 10 pp. 740–746, 6 figs., 24 refs. Easton, Pa., 1958.

The following is based on the authors' summary. In laboratory tests, rumen fluid from a cow hydrolysed 16 organic-phosphorus insecticides to varying degrees. Malathion and TEPP [tetraethyl pyrophosphate] were the most susceptible. Oxidation reactions were of much less importance than reduction reactions in metabolising the compounds, and phosphorothioates were hydrolysed much more rapidly than phosphates. The rate of reduction of radioactive parathion in the rumen fluid of a cow that ingested it was similar to that *in vitro*. Parathion, paraoxon, and their amino derivatives (O,O-diethyl O-p-aminophenyl phosphorothioate and phosphate) were found circulating in the blood of the animal and were secreted in small amounts in the milk. Amino-parathion constituted a major excretory metabolite of parathion, together with diethyl phosphoric and phosphorothioic acids. The toxicological significance of these findings is discussed in relation to the toxicity of the various derivatives. The two amino compounds are much less toxic to house-flies [*Musca domestica* L.] and rats than parathion and paraoxon.

RIEK (R. F.). **Studies on the Reactions of Animals to Infestation with Ticks. I. Tick Anaemia.**—*Aust. J. agric. Res.* **8** no. 2 pp. 200–214, 1 fig., 10 refs. Melbourne, 1957. **II. Tick Toxins.**—*T. c.* pp. 215–223, 1 pl., 2 graphs, 12 refs.

The investigations described in these two parts of a series were carried out in Queensland, and the following paragraph is based partly on the author's summary of the first of them. Steers in poor, and others in moderate or good, condition were experimentally infested with larvae of *Boophilus microplus* (Can.); they received an adequate ration and gained weight.

Heavy infestations with 50,000 larvae, from which 5,000–10,000 engorged adult females were recovered, were followed by a marked fall in concentration of red blood cells and haemoglobin content in the animals in poor condition, and by a much smaller and more temporary reduction in these components in the other animals. Even animals in good condition, when subjected to infestations twice as heavy, with recoveries of about 19,000 engorged adult females, showed a considerable reduction in the same components and in serum protein, but all these soon returned to normal levels after infestation ceased. The anaemia appeared to be caused mainly by the loss of the blood ingested by the ticks, as there was no significant change in the mean corpuscular volume or mean corpuscular haemoglobin, but it is possible that some toxic effects of the salivary secretion contributed to the slowness of recovery of heavily infested animals in poor condition even after the ticks had been removed and adequate food provided. It is estimated that the steers used might lose 30–40 per cent. of their blood when infested with 10,000 adult female ticks. Heavily infested animals would also lose considerable amounts of minerals, and thus animals in poor condition with depleted mineral reserves might be unable to replenish the blood loss as quickly as those in good condition; many such animals carried large numbers of translucent adult female ticks filled with a clear fluid similar to bovine plasma, instead of normal ticks, dark in colour owing to the ingested blood. It is known that calves under one month of age may die from anaemia, weakness and inability to feed as a result of infestation with about 500 adult females of *B. microplus*.

Investigations on tick toxins are described in the second part. Several species of Ixodids have been recorded as causing tick paralysis in man and animals in different countries. In Australia, the species responsible is *Ixodes holocyclus* Neum. [*R.A.E.*, B **15** 32; **23** 159]. As in the forms seen in South Africa and Canada [*cf.* **32** 80], the onset of paralysis coincides with the final, rapid stage of engorgement of the tick, when the salivary glands are very active, and appears to be determined by quantitative factors [*cf.* **34** 109–110]. The eggs of some species of ticks also contain a toxin, but the relation of this to the poison secreted by the salivary glands has been in doubt [**32** 18, etc.]. Tests were therefore made of the toxicity to laboratory animals of extracts of the eggs of 17 species of Ixodids and five species of Argasids, and of the larvae of four, and the nymphs and young adults of two, of the Ixodids. Macerated eggs or ticks were extracted with water or normal saline to give dilutions of 1 : 5 or 1 : 10, and the extracts were injected into laboratory animals at dose rates of 0·1–0·5 g. per kg. body weight. The toxin was shown to be present in the eggs of all the species of Ixodids tested, which included the three species that were common in the region (*I. holocyclus*, *B. microplus* and *Haemaphysalis bispinosa* Neum.) and the four other species that occur in Australia (*Amblyomma moreliae* (L. Koch), *A. triguttatum* Koch, *Aponomma hydrosauri* (Denny) and *Rhipicephalus sanguineus* (Latr.)); it was not found in any of the species of Argasids. The toxin, which was associated with the globulin portion of the egg extract and was completely destroyed by exposure for 15 minutes to 80°C. [176°F.], seemed to be present in greatest concentration in fresh eggs, but still occurred in eggs of *B. microplus* that had been stored at 5°C. [41°F.] for about six months. It was also present in freshly hatched larvae of *B. microplus*, *H. bispinosa* and the two other species tested, and toxicity decreased as the larvae aged.

The clinical syndrome and pathological changes in the tissues of the animals after injection of egg extracts were the same for all the species of tick used and indicated toxaemia. At 0·3 g. per kg., there was a rapid initial rise in rectal temperature in guineapigs, the most susceptible of the animals used, and it was followed by subnormal temperature and death.

At lower dosages, there was loss of hair at the site of injection, and an indurated, sterile ulcer usually developed. Paralysis was not normally observed but sometimes occurred if the extract was injected subcutaneously in the dorsal part of the neck [*cf.* **25** 250], as a result of the inflammatory reaction associated with the injection and not from any specific effect of the injected material. Extracts of the eggs of any one of the three common local species, and of two others tested, immunised guineapigs against the egg toxins of all five species. Extracts of the larvae of *B. microplus* or *H. bispinosa*, or of two other species, conferred immunity against egg toxins also, but egg extracts of the two named species, or of *I. holocyclus*, did not immunise, against the tick paralysis caused by salivary secretion, animals to which females of the last tick had been attached. The two toxins appear to be different. Aqueous extracts of the nymphs of *B. microplus* and *H. bispinosa* did not kill guineapigs even at 0·5 g. per kg., but sometimes produced the typical sterile ulcers and loss of hair at the site of injection. Aqueous extracts of adult males and unengorged females of *B. microplus* were slightly toxic, and those of engorged females of this species and *H. bispinosa* non-toxic, at 0·5 g. per kg.

Minter (D. M.). **Some Field and Laboratory Observations on the British Harvest Mite, *Trombicula autumnalis* Shaw.**—*Parasitology* **47** no. 1–2 pp. 185–193, 11 refs. London, 1957.

As the only method hitherto successfully used to feed the post-larval stages of *Trombicula autumnalis* (Shaw) in the laboratory was extremely laborious [*R.A.E.*, B **42** 11], an attempt was made to find a simpler procedure. The mites were collected in Kent as unfed larvae by means of a light-trap [**40** 178] or from white plates inverted on the soil, as fed larvae from trapped rodents or as adults from the soil by flotation. Mortality of larvae during engorgement was high and the process of feeding laborious so that the collection of engorged larvae was preferred. Since an almost saturated atmosphere without free moisture is needed by the mites, the larvae were kept in 2 × 1¼ in. glass tubes, the bottom of which had been covered by a half-inch layer of plaster and activated charcoal (9:1), mixed with distilled water or a 0·01 per cent. solution of merthiolate [*cf.* **45** 153] to a paste that was allowed to set. Nymphs and adults were similarly kept in screw-top glass jars. The merthiolate restricted fungus growth, and the charcoal counteracted the apparent toxicity of the plaster alone [*cf.* **37** 61] and gave a dark colour to the mixture, which lightened as the air in the vessels dried and thus indicated when it was necessary to add water to maintain the requisite air humidity. As the nymphs, which appear 20–30 days after the engorged larvae have fallen from the host, survive for only 1–3 weeks without food, whereas adults can survive for up to four months, adults were used for most of the feeding trials. Mites were kept in the dark as far as possible. Lists are given of the various foods tried, and the conditions under which they were offered are described. Living or crushed eggs and immature forms or adults belonging to five different orders of insects and various other arthropods or snails, and immature forms of miscellaneous species of Collembola obtained from sites in which adult mites were found, as well as various types of non-living substances, were tried, but positive results were obtained only with eggs of the Entomobryid, *Sinella curviseta* Brook [*cf.* **43** 180]. The mites were observed to pierce the shells and suck out the contents, and usually ate 5–6 a day. Eggs were supplied weekly or fortnightly, and the mites remained healthy and active for over eight months, but did not oviposit. The circumstantial evidence that the eggs or other immobile stages of small arthropods form the natural diet of the mites is

considered overwhelming, but soil water containing suspensions of organic matter and bacteria may also contribute to the food supply. Failure to set up a breeding colony prevented direct study of larval polymorphism [*cf.* **40** 181–182], but some incidental observations on it were made, and the possible influence of ecological isolation on the evolution of polymorphic larval types is discussed.

Rabbits (*Oryctolagus cuniculus*) were the principal hosts of the larvae in the study area before 1954, when the rabbit population was suddenly and completely destroyed by myxomatosis. However, 18 months later, adult mites were as plentiful as before in the soil in front of the deserted burrows. Possible explanations of this are adult survival for at least a year, and the replacement of rabbits as the principal larval hosts by pheasants, which are locally plentiful and often rest in the depressions in front of the burrows. The suggestion that the larvae overwinter on their hosts was not supported by catches of small rodents over three winters, which did not reveal a single larva after the first few autumn frosts.

MacLeod (J.) & Donnelly (J.). **Some ecological Relationships of natural Populations of Calliphorine Blowflies.**—*J. Anim. Ecol.* **26** no. 1 pp. 135–170, 2 pls., 1 map, 27 refs. Oxford, 1957.

The following is based largely on the authors' summary. The relation of blowfly populations to season and to vegetational environment was studied in the neighbourhood of a disused aerodrome in a mixed farming district near Carlisle from 1949 to 1953, and in less detail at three other places in the same general area. Catches with traps that were usually baited with rabbit flesh were supplemented by catches in tent-traps and also by three release-recapture experiments. At the aerodrome, serial trapping, with five bait-traps operated intermittently during the blowfly season in each year, showed this population to consist mainly of *Calliphora vicina* R.-D. (*erythrocephala* (Mg.)), and this species was the first to appear and the last to disappear. The group of *Lucilia caesar* (L.) (*L. caesar*, *L. illustris* (Mg.) and *L. ampullacea* Villen.) formed a second major component in the summer months, when it represented about 30 per cent. of the total. Within the group, *L. illustris* was slightly more frequent than *L. caesar* and *L. ampullacea* relatively scarce. *L. sericata* (Mg.) never formed more than 1 per cent. of the population, and *L. silvarum* (Mg.), *Phormia terraenovae* R.-D. and *Cynomyia mortuorum* (L.) were all present in small numbers only; *Calliphora vomitoria* (L.) formed a little under 10 per cent. of the total in the late season (mid-September to mid-October). Other species were only rarely caught. Many more females than males responded to the bait in all species except *P. terraenovae* and *Cynomyia mortuorum*, and varied according to species, seasons and habitat. The general proportions of the major species-groups in the populations were confirmed by the use of unbaited tent-traps; these were put out at night and consisted of tents with a base area of 1 sq. metre, topped by gauze cones terminating in traps, into which the morning light attracted all the blowflies that had been resting on the ground enclosed by each tent. A species-pattern similar to that round the aerodrome was found in the subsidiary investigations on reclaimed bogland and on upland sheep-grazing with both bait-traps and tent-traps.

Differences in total catch and in species-pattern between the different vegetational habitats sampled round the aerodrome are analysed in relation to season. The *caesar* group, unlike *L. sericata*, was more common in sites with canopy or tall grass and herb cover, and showed a gradation from the need for woodland, which *L. ampullacea* shared with *C. vomitoria*, to the

relative indifference to degree of cover displayed by *L. illustris*. There is possibly a shift of some members of the group into more open conditions in the late part of the season. Bait-traps, but not tent-traps, caught relatively more males of both *Calliphora* and *Lucilia* in canopy habitats than elsewhere.

The populations on different sections, moderately large areas some distances apart, were examined in August and September 1951, and in October 1953, respectively, by intensive bait-trapping with marking of the flies, their release and recapture; marking was effected on the first two occasions with paints and on the third with radioactive phosphorus [*R.A.E.*, B **45** 185]. The population of *C. vicina* was estimated at 50–200 flies per acre in August, 400–1,000 in September, and 700–1,000 in October, that of the *caesar* group at 40–70 per acre in August and September, and under 1 per acre (*Lucilia caesar*) in October. Numbers of *L. sericata* and *Cynomyia mortuorum* were estimated to be very small. Catches per trap showed significant differences in total blowfly populations between the sections. The relative order of population-density of sections sometimes changed between tests, and even within a few days during a single test, apparently through the effect of changes in numbers of *C. vicina*.

Catches per trap in the ecologically uniform subsections, small areas quite close together or contiguous, showed significant differences both in total numbers and in species-pattern. The relative level of population in different vegetational types varied between tests, and in the case of *C. vicina*, even within a few days. The apparent preferred habitats of the different species in the subsection tests were as found in the serial trap results, and similarly the males of *C. vicina* and the *caesar* group were relatively more numerous where there was canopy cover.

A concept of arenas of activity, *i.e.*, areas in which animals tend to loiter, is applied to blowflies. Some limitations to the use of the release-recapture method of estimating numbers are discussed in relation to the results [*cf.* **47** 76].

Trapido (H.) & Galindo (P.). **Mosquitoes associated with Sylvan Yellow Fever near Almirante, Panama.**—*Amer. J. trop. Med. Hyg.* **6** no. 1 pp. 114–144, 9 figs., 19 refs. Baltimore, Md., 1957.

The occurrence of a fatal case of yellow fever, in April 1951, in a member of a survey team, working in well-developed virgin tropical rain-forest a few miles from Almirante on the Caribbean coast of western Panama, led to a study, lasting over two years, of the mosquito fauna of the immediate area. The forest was characterised by a dense, evergreen, broad-leaved canopy, and the climate by high rainfall throughout the year and uniform temperature with practically no seasonal fluctuation. The workers' camp was used as a base, and collections of mosquitos coming to bite were made by two men, one on the ground and the other in the canopy (36–54 ft.) from 9 a.m. to 3 p.m. one day a week at each of four stations from May 1951 to April 1953 and from 6 to 10 p.m. also for 13 months only. Over 46,000 females of some 60 species were caught during the 3,901 man-hours of collection in the day-time catches and 1,724 females of about 35 species in 295 man-hours in the evening. The day-time catches are analysed and compared with catches made in tropical deciduous forest on the Pacific coast [*R.A.E.*, B **45** 9]. The number of females caught in each year is shown for each species, the percentage at ground and canopy levels for the 36 species of which more than 15 individuals were taken, and the daily activity and annual abundance cycles for 19 species, including five known, or suspected, to be vectors of jungle yellow fever (*Haemagogus equinus* Theo., *H. regalis* D. & K. (*lucifer*

(H., D. & K.)), *H. spegazzinii falco* Kumm, Osorno & Boshell, *Aëdes leucocelaenus clarki* Galindo, Carpenter & Trapido and *Sabethes chloropterus* (Humb.)) [*cf.* **46** 114; **47** 58].

The relative abundance of species differed in the two years, for reasons that could not be determined. Hour-to-hour fluctuations were very slight. Vertical stratification was much more pronounced than it was in the deciduous forest, only three species of those sufficiently numerous for study being more evenly distributed. The total numbers of *H. equinus* and *H. s. falco* taken were about the same (over 1,100), but whereas the first was taken in about equal numbers in the two years, the second was about twice as abundant in 1951–52 as in 1952–53. In previous work in central Panama and the Canal Zone and throughout the length of the Pacific side of Panama and adjacent Costa Rica, the authors had found *H. equinus* to be 6–8 times as abundant as *H. falco*. The relative abundance of *H. s. falco* [*cf.* **41** 26; **45** 9] is attributed to the type of forest and the type of climate, with no dry season, that supports it. *H. regalis* was somewhat less common. Identification of reared and caught males showed that the species involved was *H. regalis* and not *H. iridicolor* Dyar, which replaces it in nearby areas of Costa Rica and Nicaragua [*cf.* **45** 10 and next abstract] and has been taken along the shores of the Bahia di Almirante in Panama [**39** 212]. Catches of *Haemagogus* in the evening were negligible. *A. l. clarki*, the most abundant species of the subgenus *Finlaya*, was less plentiful than *H. s. falco* and was about twice as abundant in 1952–53 as in 1951–52. This species and the three species of *Haemagogus* were present on at least two-thirds of the days on which catches were made. *S. chloropterus* [**47** 58], the most abundant member of its genus, was 3–4 times as plentiful as any of the other four potential vectors, and was fairly evenly distributed between the two years. It was present on 96 per cent. of the days on which catches were made [*cf.* **46** 114], and may therefore help to maintain yellow fever among arboreal primates. As the five likely vector species are so completely arboreal, between 97·8 and 99·6 per cent. having been caught in the canopy, it would probably be possible to pass through the unbroken rain-forest while an epizootic was in progress among monkeys in the canopy, without incurring any danger of infection. Where the canopy is broken by clearing or even felling of a single large tree, the microclimate of the canopy is brought near the ground and there is danger of bites from arboreal mosquitos at ground level [*cf.* **45** 10]. It was the death from yellow fever of the member of the team whose duties required him to stand still in a lane freshly cleared in the forest that led to this survey.

Galindo (P.) & Trapido (H.). **Forest Mosquitoes associated with Sylvan Yellow Fever in Nicaragua.**—*Amer. J. trop. Med. Hyg.* **6** no. 1 pp. 145–152, 7 refs. Baltimore, Md., 1957.

In 1952–53, 11 fatal cases of yellow fever in man were reported from Nicaragua and there were numerous reports of deaths in monkeys, some of which were proved to be caused by yellow fever. The mosquito fauna of the forest was surveyed in the canopy and on the ground in 1953 in three localities in which evidence of jungle yellow fever had been found, one on the Caribbean slope and two on the Pacific slope. The species taken included *Haemagogus spegazzinii falco* Kumm, Osorno & Boshell, *H. iridicolor* Dyar, *H. mesodentatus mesodentatus* Komp & Kumm, *H. equinus* Theo. and *H. anastasionis* Dyar. The last-named was found only on the Pacific slope and in small numbers, and the first three were found only on the Caribbean slope. *H. iridicolor* is also present on the Pacific side in

small numbers but was not represented in the collections made. It was the most plentiful representative of its genus in catches on the Caribbean slope, which is near its centre of distribution; nearly 80 per cent. of the total was caught in the canopy, and it was probably the vector there. *H. equinus* was abundant on the Pacific side (196 and 260 per ten man-hours at the two stations), where it was fairly equally distributed between the canopy and ground-level and was probably the vector. It was comparatively scarce (1·8 per ten man-hours) on the Caribbean side and almost confined to the canopy. The densities of this species found at the stations on the Pacific slope far exceeded those found at any of the many stations operated in Panama [*cf.* preceding abstract]. As tropical deciduous forest is the optimum habitat of *H. equinus* and the Pacific side of Nicaragua must be near its centre of dispersal, the high populations found are understandable. If *H. equinus* is the principal vector of yellow fever, this might explain the fact that the disease did not proceed further on the Pacific side of Nicaragua after 1953. The mortality observed among monkeys occurred during the rainy season. In Panama, *H. equinus* is abundant in deciduous forest during the rainy season but very rare during the severe dry season, and the same probably applies in Nicaragua; it also needs a high humidity to survive long enough for the extrinsic incubation period of the virus to be completed, and is therefore probably neither numerous nor long-lived enough in the dry season to maintain transmission. The absence of *H. s. falco* from the collections on the Pacific side is probably due to the fact that Nicaragua is at the periphery of its range [*cf.* **45** 34] and its optimum habitat is the rain-forest. *H. m. mesodentatus* is an Atlantic-slope form [*cf.* **47** 57] except for a break-through to the Pacific side in Costa Rica, and it is not common south of Guatemala. *Aëdes leucocelaenus clarki* Galindo, Carpenter & Trapido was present on the Caribbean side only and was near the limit of its range [*cf.* **42** 115]. The numbers of the last three species were too small for them to have been significantly involved in transmission. *Trichoprosopon magnus* (Theo.) was present on the Caribbean side only, where it was the commonest canopy species [*cf.* **45** 34]; its ability to transmit has not been determined. *Sabethes chloropterus* (Humb.) was taken on both the Caribbean and Pacific slopes. It is considered an important species in carrying virus over the dry season in Panama [*cf.* **46** 114, etc.], but its significance in this respect in Nicaragua could not be assessed as no collections were made at that time of year.

Barr (A. R.). **The Distribution of** *Culex p. pipiens* **and** *C. p. quinquefasciatus* **in North America.**—*Amer. J. trop. Med. Hyg.* **6** no. 1 pp. 153–165, 9 figs., 10 refs. Baltimore, Md., 1957.

The following is almost entirely from the author's summary. The DV/D ratio [*R.A.E.*, B **40** 187] was calculated for about 3,500 males of *Culex pipiens pipiens* L. and *C. p. fatigans* Wied. (*quinquefasciatus*, auct.), mostly from the United States. It averaged usually 0·1 or less for *C. p. pipiens* and 0·6 or more for *C. p. fatigans*. In individual specimens, the ratio was usually less than 0·2 in the former and more than 0·4 in the latter; specimens with ratios between these values were classed as intermediates. In North America, only *pipiens* is usually found north of 39°N. lat. and only *fatigans* south of 36°N. Collections from between these latitudes may consist of only one form or the other, or of mixtures of them with or without intermediates. There seems little doubt that the forms hybridise in nature. In some localities such as Sacramento in central California, intermingling seems to be much freer than in others such as East St. Louis, Illinois. It is concluded

that at present it seems wisest to retain subspecific names for the two forms. Present evidence indicates that the inheritance of the DV/D ratio is multifactorial. One collection of *pipiens* from a mountainous locality in Arkansas, in the range of *fatigans*, suggested that the cline from *pipiens* to *fatigans* might be found on the sides of mountains in the *fatigans* zone.

Kilpatrick (J. W.) & Schoof (H. F.). **Fly Production Studies in urban, suburban, and rural Privies in southeastern Georgia.**—*Amer. J. trop. Med. Hyg.* **6** no. 1 pp. 171–179, 4 figs., 3 refs. Baltimore, Md., 1957.

Surveys in Arizona and Texas having shown that production of *Musca domestica* L. was greater in privies treated with dieldrin than in untreated ones [*R.A.E.*, B **44** 30; **46** 57], the matter was investigated in a series of studies carried out near Savannah, Georgia [*cf.* **46** 161]. Qualitative and quantitative data gathered between December 1952 and December 1953 on the fly populations of untreated privies to serve as a basis of comparison are given in this paper. The 100 privies used had originally had pits 2–3 ft. deep, but more than 60 per cent. of these had been almost completely filled. They were classed as urban, suburban or rural, according to situation, but in general, there was no great difference in the flies obtained from the three types.

More than 175,000 adults belonging to 33 families of Diptera were collected, and the 170,401 that were fully identified represented 97 species. Of these, the only ones that occur in any numbers in houses or food-handling establishments and were therefore likely to be of medical significance were *M. domestica*, *Culex pipiens fatigans* Wied. (*quinquefasciatus*, auct.), species of *Ophyra* and *Drosophila*, and Calliphorids. The predominant species varied from month to month, and *M. domestica* was relatively most numerous in January when it formed only 6 per cent. of the total. Emergences from the privies reached peaks in spring and autumn and were low in summer, contrasting with the peak in the overall fly population (largely *M. domestica*), which usually occurs in June and July, in the Savannah area.

de Rodaniche (E.) & Galindo (P.). **Isolation of Yellow Fever Virus from *Haemagogus mesodentatus*, *H. equinus* and *Sabethes chloropterus* captured in Guatemala in 1956.**—*Amer. J. trop. Med. Hyg.* **6** no. 2 pp. 232–237, 13 refs. Baltimore, Md., 1957.

Jungle yellow fever was reported in Panama in the late autumn of 1948 [*cf. R.A.E.*, B **39** 212; **46** 114, etc.], and outbreaks appeared successively in Costa Rica [**45** 10], Nicaragua [**47** 92] and Honduras [**45** 34]. The northward sweep reached Guatemala early in 1956, and in order that attempts might be made to isolate the virus from mosquitos, collecting stations were established in two areas in the Motagua valley in which yellow fever was first observed among monkeys in February and May. Earlier attempts to isolate virus from mosquitos from Panama and Honduras had been unsuccessful [*cf.* **46** 130]. Of nearly 10,000 mosquitos received at the laboratory in Panama from the Guatemala stations, 1,686 were *Haemagogus equinus* Theo., 4,021 *H. mesodentatus* Komp & Kumm and 3,141 *Sabethes chloropterus* (Humb.); 3, 14 and 4 isolations of virus were made from these species, respectively, by intracerebral injection into mice. No virus was isolated from any of the other species, none of which belonged to the genus *Haemagogus*. The number of mosquitos in the positive pools varied from 31 to 163, and there were positive pools of all three species from both

localities. This is the first record of the isolation of yellow-fever virus from *H. mesodentatus* or *S. chloropterus* and from pure pools of *H. equinus*, though it had previously been isolated from a mixed pool of *H. equinus*, *H. spegazzinii falco* Kumm, Osorno & Boshell and *H. regalis* D. & K. (*lucifer* (H., D. & K.)) [**33** 112] and from a mixed pool of Sabethines including the subgenus *Sabethoides* [**27** 121]. Obviously engorged females were discarded from the experiments, but a few individuals were found to contain small amounts of fresh blood on trituration, and it is possible that the presence of virus may have been due to these. The results indicate that *H. mesodentatus*, which has been shown to transmit infection readily by biting [**47** 58], is locally the most important vector.

Elbel (R. E.) & Thaineua (M.). **A Flea and Rodent Control Program for Plague Prevention in Thailand.**—*Amer. J. trop. Med. Hyg.* **6** no. 2 pp. 280–293, 4 figs., 11 refs. Baltimore, Md., 1957.

Plague appeared in Siam in 1904 and has been endemic there ever since, with the possible exception of the years 1935–37. In the period 1943–52, the monthly incidence rose from a minimum in June (the rainy season) to a maximum in February at the end of the cool season. Until the end of 1951, control measures were instituted only after human cases had been detected, but as a result of an epidemic at that time and another early in 1952, permanent laboratories were established for plague detection and control in the main city of each of the three known infected areas, and routine measures were used in an attempt to prevent the occurrence of human cases. An account is given of the work of these laboratories between February 1952 and September 1953. During this period, 48,553 domestic rats (*Rattus exulans concolor*) were trapped alive and these and their fleas and some animals collected from the fields and forests were tested for the presence of plague. Infection was found only in the rats and in *Xenopsylla cheopis* (Roths.) taken from them. Indices of this vector [numbers per rat] were computed monthly, and an attempt was made to institute control measures in villages, towns or sections of towns, whenever human cases occurred, or evidence of plague was found in rats or fleas, or the local *cheopis* index rose above 1·0. This figure was chosen because Hirst had postulated that where *X. cheopis* was the principal vector, there was no danger of an epidemic so long as the *cheopis* index remained below 1·0 [*cf. R.A.E.*, B **21** 104]. Rat-runs and harbourages were usually dusted with 10 per cent. DDT in calcium carbonate from hand dusters or shakers, and this treatment was followed by a programme of rat poisoning.

To assess the results, monthly data from the three cities for the period August or September 1952 to September 1953 were examined critically. Banpong was given a complete treatment in January 1952, and two sections showing many rats and high flea indices were treated in June and July 1953; it was, therefore, virtually an untreated area for most of the time. The curve for the *cheopis* index there, which for most of the time was above 1·0, closely paralleled the curve for monthly incidence of plague in the whole country in 1943–52. The index fell to 0·75 in October, rose to 2·03 in February, fell to 1·1 in April and, after the June–July treatment during which it rose somewhat, fell to 0·66 in September. Khorat received partial treatments in December 1952 and September 1953 in sections in which the *cheopis* index rose above 1·0. The general level of infestation remained below this except in August and September 1953, possibly owing to climate. Nakhon Sawan was completely dusted in October–December 1952, when the index had risen to 1·16, and one section, in which the index had again risen

above 1·0, was re-treated in February 1953. The index for the whole city began to decline after the first treatment, continued to drop steadily and was below 0·5 for the last five months. As there were no cases of plague in man in the study areas during the observation period, the effectiveness of the DDT treatment in preventing the occurrence of the disease in the cities was not proved. Infection in rats or fleas was detected only three times, once in each area, and was not apparently connected with high flea densities.

Dow (R. P.), Reeves (W. C.) & Bellamy (R. E.). **Field Tests of avian Host Preference of *Culex tarsalis* Coq.**—*Amer. J. trop. Med. Hyg.* **6** no. 2 pp. 294–303, 2 figs., 9 refs. Baltimore, Md., 1957.

The host preferences of mosquitos are of importance in epidemiological studies. The usual approach by the identification of blood meals has proved of limited value in indicating the host preferences of *Culex tarsalis* Coq., a vector both of encephalitis and avian malaria, although it has been shown to feed on a wide range of birds. Comparative tests were therefore made in California, between June and October 1955, with traps that had been baited with birds and were slowly rotated some 5 ft. above ground level about a common vertical axis. Similar numbers of *C. tarsalis* were attracted to birds of the same size whether these were of the same or different species, and more were attracted to larger birds whether these were larger individuals of the same species or examples of a larger species. Rates of engorgement were independent of attraction rates and size of bird, and they varied for different species of bird and for different individuals of the same species. Engorgement rates on individual birds were usually consistent, with only a few instances of night-to-night differences. From July to December 1955, observations were made on the number of females of *C. tarsalis* caught overnight in fixed traps hung in trees and baited with chickens and the proportion of those caught that engorged. Increased catch was found to be correlated with a decreased proportion engorging. In another series of observations in July in which many different kinds of birds, two kinds of mammals, and snakes and toads were exposed overnight in a rural area, *C. tarsalis* was attracted to and fed on both mammals, the snakes and all the species of birds except one, but did not feed on toads and was virtually not attracted to them. Biting rates of *C. tarsalis* on avian hosts and consequent risk of infection with the agents of mosquito-borne disease are undoubtedly influenced by a combination of the attractiveness of the host and its acceptability.

Papers noticed by Title only.

Audy (J. R.). **A Checklist of Trombiculid Mites of the Oriental and Australasian Regions** [with distribution and host records supplementary to those given by Wharton & Fuller (*R.A.E.*, B **41** 50)].—*Parasitology* **47** no. 1–2 pp. 217–294, 26 figs., 3½ pp. refs. London, 1957.

Ferris (G. F.). **Insects of Micronesia. Vol. 8 no. 2. Anoplura.**—pp. [5+] 9–12, 4 figs., 1 map. Honolulu, Bishop Mus., 1959. [*Cf. R.A.E.*, B **45** 87; **46** 68.]

Proceedings of the Tenth International Congress of Entomology, Montreal, August 17–25, 1956. Section on Behaviour, including Social Insects. —*Proc. 10th int. Congr. Ent.* 2 pp. 395–615. Ottawa, 1958. **Section on Ecology.** — *T.c.* pp. 617–784.

The following are abstracts of selected papers containing hitherto unpublished information of which the text is printed in full in these sections [*cf. R.A.E.*, B **47** 74].

ROGOFF (W.M.) & BARTON-BROWNE (L.B.). **The Oviposition Behaviour of the Australian Sheep Blowfly,** *Lucilia cuprina* **(Wied.),** pp. 589–593, 5 refs. The following is based on the authors' abstract. Earlier workers showed that *Lucilia* spp. laid eggs more readily near cotton wads soaked in indole and ammonium carbonate (artificial putrefaction or *P* factor) on living sheep than near similar plugs in *in vitro* fleece preparations or on pelts of sheep; a sheep or *S* factor of unknown character, possessed only by living sheep, was postulated to explain this [*cf.* **25** 52; **33** 181]. Results obtained with *L. cuprina* (Wied.) in a continuing investigation in Australia to determine the nature of this *S* factor are described.

Comparisons were made between living sheep and *in vitro* preparations, as well as between living sheep and pelts with their undersides carefully isolated from the experimental situation. Comparisons were also made between similar pelts and *in vitro* preparations. The differences noted do not support the importance of "liveness" in inducing oviposition, but rather the importance of surface area (perhaps involving chemical as well as visual factors) when making comparisons with small *in vitro* preparations. The observations tended to agree with those of Cragg [**45** 54–56, etc.].

The importance of spaces or cavities between the staples of a size permitting the entry of the flies was demonstrated. In *in vitro* preparations, the amount of oviposition and the placement of the eggs was controlled by altering the number and position of the cavities. There was evidence of heavier oviposition on sheep with open fleece (having more cavities) than on those with dense fleece.

A comparison of fleece with other fibres showed the superiority of wool to most others tested, except that the superiority of cattle hair (tied into staple-like bundles) over wool was marked. It is suggested that the *S* factor is not limited to living sheep and that living sheep are not greatly attractive (or effective in inducing oviposition) as compared with pelts of freshly killed sheep. It is suggested that the *S* factor at least includes physical (probably tactile) phenomena and that this factor or complex of factors is not peculiarly a characteristic of fleece alone.

KUENEN (D.J.). **Competition in Laboratory Cultures of** *Musca domestica*, pp. 767–774, 8 graphs, 4 refs. In the experiments described, eggs of *Musca domestica* L. deposited within a few hours were transferred to glass jars of 1-litre capacity containing 100 g. of a mixture of 1,000 ml. water, 250 g. powdered skimmed milk, 200 g. cellulose tissue, 13 g. dried yeast powder and enough potassium-hydroxide solution to raise the pH to 7.8 and suppress fungus growth. The number of eggs per jar varied from 100 to 3,000, and 80–95 per cent. of these hatched. Records were made of the number and weight of the puparia formed. The number increased with the number of eggs per jar until the latter reached 1,000, and then decreased, while the percentage of larvae that pupated remained the same up to 500 eggs per jar and then decreased. The individual weights of the puparia decreased from the lowest concentration onwards. The total biomass (a combination of mean weight and numbers) was greatest for medium numbers of eggs. With the latter, the formation of puparia was often discontinuous,

production decreasing at first and then increasing, the weight of the puparia increasing likewise. This is thought to be due to the disappearance of the first larvae, which hamper the slower and smaller larvae in their earlier periods of development. The maximum production of dry weight of puparia was about 15 per cent. of the dry weight of the food substances present in the culture medium.

FISHER (R.W.) & JURSIC (F.). **Rearing Houseflies and Roaches for physiological Research.** — *Canad. Ent.* **90** no. 1 pp. 1—7, 6 figs., 2 refs. Ottawa, 1958.

Details are given of the equipment and procedures used in a laboratory at London, Ontario, in rearing *Musca domestica* L. and *Periplaneta americana* (L.) for physiological research. The basic feature of the method for *M. domestica* is the use of milk as the major constituent of the larval medium [*cf. R.A.E.*, B **37** 57]. Stock cages, which measure 12 x 12 x 16 in., are used in batteries of eight. Each day, one batch of 1,000 pupae ready for emergence (about 25 g.) is added to a cage at one end, and the flies seven days old in the cage at the other are killed, and the cage cleaned. Adults are supplied with diluted whole or evaporated milk on absorbent cotton in a feeding dish, a dry ration of 1 part dried brewer's yeast, 3 parts whole milk powder and 6 parts sugar, and a water fountain. Petri dishes, containing two wads of absorbent cotton saturated with milk and folded to leave a cleft between them, are provided for oviposition. The eggs, obtained from the last four cages, are transferred to a layer of larval medium on the bottom of a battery jar 8½ in. in diameter; the medium consists of 75 g. of an absorbent cellulose product (Cellucotton) minced or shredded into pieces about 1 in. long and uniformly wetted with a fluid made from 540 ml. evaporated milk, 360 ml. water and 21 g. dried brewer's yeast. Eggs are added at 0.7 ml. per jar, and the jars are covered and stored at 28° C. [82.4°F.] and 55—60 per cent. relative humidity. After five days, sawdust is added for pupation. Pupae that are retained by a sieve, with apertures measuring 3/32 in., are kept for testing and rearing. The mean number of eggs in a jar was 5,250, producing an average of 4,600 pupae, or 8.5 flies per g. evaporated milk.

Very young nymphs of *P. americana* are kept in gallon glass jars with a water fountain attached to the screw cap and a corrugated cardboard lining round three sides. This affords a surface for 1,500—2,000 nymphs. The food consists of dog biscuits, yeast and sugar on a layer of sawdust. Nymphs in about the third instar are transferred to cages consisting of aluminium boxes, with screen sides, measuring 16 x 13 x 10 in. and containing a corrugated cardboard spacer, of the type used to protect bottles in cartons, set so that its 24 compartments (each 2¼ in. by 2½ in.) open horizontally, and a 4-in. space is left for the tube from a water fountain, fastened outside the box, and a feeding basket of ¼-in. wire cloth. A cage holds about 100 adult cockroaches and larger numbers of nymphs. With 20 cages, it is estimated that about 2,000 adults can be produced each week. Egg capsules are taken from the cages and placed in ½-in. layers in Erlenmeyer flasks, from which the newly emerged nymphs are cleared weekly or oftener. Weight records are kept at different instars or ages and the correct number of cockroaches for each cage is calculated by weight. At 27° C. [80.6° F.] and 60 per cent. relative humidity, the culture reaches maturity in about four months.

MALLISON (G.F.), WILLIAMS (E.R.) & RICHARDS (C.S.). **An Apparatus for rapid indoor Collection of Adult Flies.** — *Canad. Ent.* **90** no. 1 pp. 61—62, 1 fig., 4 refs. Ottawa, 1958.

The device described was designed and has been extensively used in Arizona for the rapid collection of flies inside inhabited dwellings, which often have no electric power. It consists of a portable vacuum cleaner fitted with a transparent plastic wand bulged at the distal end to accommodate the collecting containers. These are transparent plastic tubes 2 in. long and 1¼ in. in diameter threaded for screw-top lids and having a 7/8-in. hole in the bottom covered by a tightly fitting disk of wire screen that retains the flies but allows free passage of air. When the desired number of flies has been collected, a lid is screwed on and the tube then serves as a storage container. The device is operated on a cable from a petrol-powered generator on a truck. The transparent tube and wand cause minimal disturbance to resting flies.

FALLIS (A.M.) & WOOD (D.M.). **Biting Midges (Diptera: Ceratopogonidae) as intermediate Hosts for *Haemoproteus* of Ducks.** — *Canad. J. Zool.* **35** no. 3 pp. 425—435, 1 pl., 17 refs. Ottawa, 1957.

The following is largely based on the authors' abstract. *Haemoproteus nettionis* was transmitted to domestic ducks in nature in Algonquin Park, Ontario, in late June and in July in 1954, 1955 and 1956. This coincided with the season of abundance of *Simulium rugglesi* Nicholson & Mickel and biting midges (Ceratopogonids). Transmission experiments with *S. rugglesi* and with mosquitos were negative. Further investigations showed that *H. nettionis* was transmitted during the night, at which time certain ornithophilous biting midges fed on the ducks. Among them, an undescribed species of *Culicoides* predominated and this was the only one caught when cages were placed over ducks. These midges were shown experimentally to be suitable intermediate hosts for *H. nettionis*. Ookinetes and structures identified as oocysts and sporozoites were found in midges that were sectioned after feeding on infected ducks, and *H. nettionis* was seen in the peripheral blood of other ducks 14—21 days after they had been infected by injection of suspensions of midges that had fed on ducks harbouring *Haemoproteus*. The gametocytes needed 4—6 days to reach maturity.

DOWNE (A.E.R.). **Precipitin Test Studies on Rate of Digestion of Blood Meals in Black Flies (Diptera: Simuliidae).** — *Canad. J. Zool.* **35** no. 3 pp. 459—462, 5 refs. Ottawa, 1957.

The following is based largely on the author's abstract. Adult Simuliids were allowed to engorge on known hosts (horses or guineapigs) and then retained for periods of 8—48 hours in a laboratory incubator at 67—70° F. and 75—80 per cent. relative humidity or under field conditions, when maximum, minimum and mean temperatures varied from 59 to 97, 47 to 74 and 51 to 83° F., respectively, and relative humidity from 51—90 per cent. Precipitin tests carried out on smears taken at the end of these periods showed that the source of the meal could be identified almost always after 8—24 hours, in 74 per cent. of the specimens kept in the incubator and 60 per cent. of those kept in the field after 32 hours, in few after 40 hours, and in hardly any after 48 hours. The field results indicated that the rate of digestion is accelarated when mean temperatures are comparatively

high and noticeably retarded when they are low [*cf. R.A.E.*, B **41** 209]. There were no striking differences in the rates of digestion of the four species of Simuliids used.

KNAPP (F.W.), TERHAAR (C.J.) & ROAN (C.C.). **Field Studies with Feed and Bolus Formulations of Dow ET-57 for Control of Cattle Grubs.** — *J. econ. Ent.* **51** no. 2 pp. 119—122, 2 graphs, 1 ref. Menasha, Wis., 1958.

The possibility of controlling cattle grubs (*Hypoderma* spp.) by the systemic action of Dow ET-57 [purified O,O-dimethyl O-2,4,5-trichlorophenyl phosphorothioate] administered orally to the host has recently been demonstrated [*cf. R.A.E.*, B **46** 139, 183; **47** 14; etc.]. To avoid the individual handling that the use of a bolus requires, the effect of adding ET-57 to the feed was investigated in field experiments carried out in Kansas in the autumn of 1956. All treated animals were given 110 mg. ET-57 per kg. body weight. Larvae, located by palpation, were counted every month or every 28 days for about four months. At Hays, 118 Hereford steers that received boluses and 117 that remained untreated showed average increases of 0.5 and 11.04 larvae per animal, respectively, in the course of the observation period. At Manhattan, 80 Hereford cattle received boluses, 80 others received the insecticide in their feed and 84 were untreated, and the three groups showed average increases of 0.38, 0.25 and 3.2 larvae per animal, respectively. There were no consistent differences in gains in weight between treated and untreated animals. Blood-cholinesterase investigations on 30 of the Manhattan animals, ten from each group, showed that ET-57 markedly depressed enzyme activity. This effect was slower but somewhat greater in the cattle that received the compound in their feed instead of in boluses. Recovery of enzyme activity was essentially the same in both groups. No toxic symptoms were observed in any of the experimental animals.

HEWITT (R.), BREBBIA (A.) & WALETZKY (E.). **Carbamoyl Alkyl Phosphorodithioates as Chemotherapeutic Agents: Screening by Aedicidal Properties in Laboratory Mammals, Lambs and Calves.** — *J. econ. Ent.* **51** no. 2 pp. 126—131, 17 refs. Menasha, Wis., 1958.

Screening and preliminary evaluations of certain compounds as systemic agents for the control of *Hypoderma* in cattle were carried out with *Aëdes aegypti* (L.) and mice, and further evaluations with *A. aegypti* and guineapigs, rats, sheep or cattle. The usefulness of *A. aegypti* was indicated by the fact that, of 13 well-known insecticides administered orally to mice at dosages tolerated by the latter, nine killed mosquitos that fed on the mice and, of the seven insecticides tested that are known to be active against *Hypoderma* [see preceding abstract, etc.], only diazinon [O,O-diethyl O-2-isopropyl-4-methyl-6-pyrimidinyl phosphorothioate] failed to do so. Of some 150 organic phosphorus compounds, the most interesting were the carbamoyl alkyl phosphorodithioates and the most active of the 19 of those tested was O,O-dimethyl S-(methylcarbamoyl)methyl phosphorodithioate (Am. Cyanamid 12,880), for which the common name dimethoate is used. This had an ED50 (dose killing about half the mosquitos feeding) of about 6 mg. per kg. in mice and calves but at about this dose it was more active in rats and less active in lambs and guineapigs; at 10—15 mg. per kg. it killed between 76 and 96 per cent. of the mosquitos feeding on

all five hosts. It has a chemotherapeutic index (LD50/ED50) of about 25 in mice. Severe, reversible toxic symptoms appeared in lambs and calves that received 40—60 mg. per kg. orally and lethal effects with 80—100 mg. per kg. The margin between the dose toxic to feeding females of *A. aegypti* and that toxic to the host is thus appreciable in these ruminants but narrower than in mice.

Toxicity to the mosquitos decreased rapidly at some time between 4 and 24 hours after administration. Concentrations lethal for *A. aegypti* were present in the blood of various mammals within one hour of the administration of 10—25 mg. dimethoate per kg. orally, intramuscularly or subcutaneously. It was not established that any given route was superior. In calves, the oral route was effective with the compound given by drench, bolus or gelatin capsule; an intramuscular injection was effective with a water and acetone solution or with a 50 per cent. diethylsuccinate solution. Groundnut oil was the vehicle used for intramuscular and subcutaneous injection of the compound into sheep. Preliminary data indicated that single oral doses of 12.5 mg. per kg. were partly effective against natural infestations of *Polyplax* sp. on mice. The ED50's, for *A. aegypti*, of six of ten other analogues of the O,O-dimethyl series of carbamoyl alkyl phosphorodithioates, administered to mice as single oral doses, were 30—74 mg. per kg. and, of the unsubstituted carbamoyl member, 135 mg. per kg. Dimethoate was not only the most active member of the series, but also had the highest margin of safety, with the exception of O,O-dimethyl S-(tert.-butyl carbamoyl)methyl phosphorodithioate, which had a chemotherapeutic index of 35 but an ED50 of 30 mg. per kg. Eight carbamoyl alkyl phosphorodithioates in which dimethyl was replaced by diethyl, dipropyl or di-isopropyl, were generally inactive at doses tolerated by mice or were more toxic to the latter than the corresponding dimethyl compounds.

CHENG (Tien-hsi) & VANDERBERG (J.P.). **The Treadle Sprayer and the Cable-type Back Rubber for Control of Biting Flies on Cattle in Pennsylvania.** — *J. econ. Ent.* **51** no. 2 pp. 149—156, 5 figs., 12 refs. Menasha, Wis., 1958.

The following is based largely on the authors' abstract. The effectiveness of various insecticidal and repellent formulations applied by means of self-treatment devices for the control of *Siphona irritans* (L.) and *Stomoxys calcitrans* (L.) on cattle in Pennsylvania was tested during 1955 and 1956. A spray containing 50 per cent. butoxy polypropylene glycol and 5 per cent. methoxy-DDT (methoxychlor) in methylated naphthalenes was tested during 1955 with a treadle sprayer [*R.A.E.*, B **39** 153] and a cable-type back rubber [**40** 131; *cf.* also **43** 118]. The latter was attached by one end, at a height of 5 ft., to a tree or post and, at the other, to a ground anchor. With one round-trip application daily from the treadle sprayer (during which each animal received about 4 ml. spray) on 21 occasions, percentage control of *Siphona* and (in brackets) *Stomoxys* was 94.7, 92.8, 91.2 and 82.9 (59, 59.6, 10.6 and 6.4) one, three, four and seven hours after treatment, respectively. Because of the excitement and nervousness caused among the animals, about one-third of those going through the sprayer received only partial treatment or none. The back rubber installed in a small pasture with a few trees gave almost perfect control of *Siphona*, but less satisfactory control of *Stomoxys* [*cf.* **40** 131; **42** 188; **45** 116]. There was a significant decrease in effectiveness in a wooded pasture with numerous dead trunks and branches that competed as rubbing places with the device but decrease was shown in later studies in wooded pastures

without this competition. After the animals were denied access to the rubbers, percentage control of *Siphona* throughout a post-treatment period of 25 days fell from 99.7 in the first five-day period to 52.5 in the fifth, and effectiveness against *Stomoxys* lasted for less than 20 days, the control percentages being 53, 33, 54.4 and 0 in the four five-day periods.

In 1956, units of a portable version of the rubbing device were used, in which the lower end was attached to a spring clamped to an eye-bolt in a concrete block, and the block was held in place by small stakes. The rubbers were treated with the formulation used in 1955 or one of three others, the principal ingredients of which were 5 per cent. methoxy-DDT in diesel oil, 10 per cent. butoxy polypropylene glycol and 4 per cent. methoxy-DDT in diesel oil, and 8.6 per cent. butoxy polypropylene glycol, 1 per cent. methoxy-DDT, 0.6 per cent. Lethane 384 [50 per cent. n-butyl carbitol thiocyanate in kerosene] and 0.03 per cent. pyrethrins with a synergist in petroleum distillate, and they were installed indoors in a basement barn and in three pastures of different sizes and with different numbers of trees, but relatively free of dead trunks or stumps. All formulations provided effective and consistent control of *Siphona*, and no significant difference was found under the different conditions. Excellent control of *Siphona* was provided by 5 per cent. methoxy-DDT in diesel oil and the addition of butoxy polypropylene glycol did not significantly enhance its effectiveness. None of the formulations provided satisfactory control of *Stomoxys*, and there was considerable variation in the effectiveness of each formulation. The less satisfactory results against this species, which feeds mainly on the legs, may be due to failure of the cattle to rub their legs on the device to any great extent and to their habit of wading through mud holes. None of the materials tested on the back rubber had any apparent adverse effects on the animals used in the experiments, but two month-old calves lost large patches of hair, refused to eat and grew listless when they had access to a rubber treated with butoxy polypropylene glycol and methoxy-DDT in diesel oil, though they recovered when this access was denied.

RODRIGUEZ jr. (J.L.) & RIEHL (L.A.). **Malathion for Control of Chicken Mites on Hens in Wire Cages.**—*J. econ. Ent.* **51** no. 2 pp. 158–160, 2 figs., 5 refs. Menasha, Wis., 1958.

In southern California, aqueous sprays containing 0.5 and 1 per cent. by volume of actual malathion from an emulsion concentrate were applied, for the control of *Dermanyssus gallinae* (Deg.) [*cf. R.A.E.*, B **45** 141] with a power-driven sprayer to the inside and outside of the wooden framework of poultry cages, provided with wire-mesh raised floors and containing 35–40 hens. Both concentrations gave apparently complete control of *D. gallinae* in the cages and of a light infestation of *Ornithonyssus sylviarum* (C. & F.) that occurred on a not very high percentage of the hens; the control lasted throughout an observation period of seven months. Whether the same concentration and method of application would control *O. sylviarum* consistently is doubtful. Complete control of *D. gallinae* was obtained with a single application of 4 per cent. malathion dust, in individual-type cages, constructed entirely of wire, that accommodated two hens and were joined in blocks of eight. Eggs were collected, and food and water containers removed, before treatment; during spraying, the hens were moved aside and not treated intentionally, but some were wetted by drift and contact with treated surfaces; during dusting, only the feet and shanks of the legs were hit by the dust.

O'BRIEN (R.D.) & FISHER (R.W.). **The Relation between Ionization and Toxicity to Insects for some Neuropharmacological Compounds.** — *J. econ. Ent.* **51** no. 2 pp. 169–175, 24 refs. Menasha, Wis., 1958.

The following is based on the authors' abstract. In order to study the rôle of ionisation in the toxicity of neural poisons to insects, the authors examined the toxicity of 35 neuropharmacological agents to insects of five species, including *Musca domestica* L. and *Periplaneta americana* (L.), and mice. Comparison of the observed ratios of mammalian to insect toxicity with those calculated on the hypothesis that the whole compound is effective in the mouse, but only the non-ionised fraction in the insects, confirmed this assumption for nitrogenous anticholinesterases and showed clearly that convulsants are intrinsically ineffective against insects. With other agents, the factors are more complex.

GERSDORFF (W.A.) & PIQUETT (P.G.). **Effect of molecular Configuration on relative Toxicity to House Flies as demonstrated with the four *cis* Isomers of Allethrin.** — *J. econ. Ent.* **51** no. 2 pp. 181–184, 10 refs. Menasha, Wis., 1958.

In a comparison of the relative toxicity of the four optically active *cis* isomers of allethrin [*cf. R.A.E.*, B **45** 72], the median lethal concentrations (LC50's) for house-flies (*Musca domestica* L.) of the *l-l*, *d-l*, *l-d* and *d-d* esters (the first and second letters of each pair being used to show the optical activities of the allethrolone and acid components of the molecule, respectively) were found to be 0.06, 0.14, 0.33 and 1.77 times that of allethrin (93.4 per cent. pure), in kerosene space sprays applied by the turntable method [**26** 246]. The expected and found toxicities of an equiproportional mixture of the four isomers were, respectively, 0.574 and 0.617 times that of allethrin, [*cf.* **47** 30–31]. As the difference was not significant, it is concluded that the four stereoisomers were acting similarly.

The two racemic forms of these *cis* isomers would be the equiproportional mixtures of the *l-d* and *d-l* esters and of the *d-d* and *l-l* esters. They have not been separated since one of them does not crystallise out as does *α-dl-trans*-allethrin [**40** 116–117], but their toxicities relative to allethrin were calculated from those of the esters to be 0.233 for the first pair, which may therefore, in conformity with the corresponding *trans* pair, be called *α-dl-cis*-allethrin, and 0.916 for the second, the *β* racemic form.

The complete bioassay of the optically active constituents of allethrin, based on these relative toxicities and previous ones [**41** 125; **42** 135; **45** 141; **47** 31], is given, and calculations from it show that the percentages in allethrin of the *α* and *β* racemic forms of the *cis* and *trans* isomers are 16.1, 13.6, 24.7 and 45.6, respectively.

The relative toxicities of the *cis* stereoisomers do not fall into a regular pattern, as do those of the *trans* compounds [**42** 135]. With the acid and (in brackets) the allethrolone component of the molecule of the *l* form, the change from the *l* to the *d* form of the allethrolone (acid) component increased the toxicity of the ester by a factor of 2.4 (5.8). With the acid or allethrolone components of the *d* form unchanged, a change in the other component from the *l* to the *d* form increased toxicity by 2.2 times the above factors. The effect of a change in each component simultaneously from the *l* to the *d* form equalled the product of the separate effects. All the stereoisomers caused complete or nearly complete knockdown at the concentrations used, which varied between 119 and 600, 267 and 900, 20 and 100, 593 and 2,000, and 59 and 300 mg. per dl. for the *cis* isomers and for the equiproportional mixture, respectively.

LINKFIELD (R.L.) & REID (W.M.). **Newer Acaricides and Insecticides in the Control of Ectoparasites of Poultry.** — *J. econ. Ent.* **51** no. 2 pp. 188—190, 4 refs. Menasha, Wis., 1958.

Replies to an inquiry on the incidence of *Ornithonyssus sylviarum* (C. & F.) on poultry in the United States and Canada indicated that the mite was increasing in 18 widely distributed States, while only Washington State reported a decrease. In 20 other States and Canada, the mite was said to be present, and the remaining nine States reported no experience. The increasing size of commercial poultry flocks necessitates mass treatment, preferably with dusts. Use of malathion [*cf. R.A.E.*, B **45** 114] has been highly recommended, but 4 and 5 per cent. malathion dusts, applied in accordance with the manufacturer's directions, failed to eradicate the mite in tests in Georgia in 1955, and failure has also been reported from Alabama and Michigan. Experiments were therefore undertaken in Georgia on the value of other synthetic acaricides.

The following is based largely on the authors' summary of the results. Of seven dusts tested on individual fowls in screening experiments, those containing 5 per cent. Sevin (1-naphthyl N-methylcarbamate), 1.5 per cent. dieldrin, 25 per cent. dimethyl phthalate and 25 per cent. 2-ethyl-1,3-hexanediol were ineffective, but 5 per cent. Dow ET-57 [O,O-dimethyl O-2,4,5-trichlorophenyl phosphorothioate], 10 per cent. Sulphenone [p-chlorophenyl phenyl sulphone] and 5 per cent. Trithion [O,O-diethyl S-p-chlorophenylthiomethyl phosphorodithioate] showed promise. In a field test with the Sulphenone dust applied by hand to litter and nests at 1 lb. per 20 sq. ft., mites persisted on several birds after 28 days. The criterion of eradication was failure to find any mites on the birds for eight weeks after treatment. In two field experiments, the ET-57 dust similarly applied at 1 lb. per 40 and per 20 sq. ft. brought about complete eradication for eight or more weeks, and the Trithion dust was equally effective. ET-57 at 1 lb. per 20 sq. ft. also eradicated *Menacanthus* (*Eomenacanthus*) *stramineus* (Nitzsch), *Menopon gallinae* (L.), *Lipeurus caponis* (L.) and *Goniocotes gallinae* (Deg.) in one of the field trials. A 5 per cent. malathion dust applied by hand over a whole pullet house at 1 lb. per 75 sq. ft. and again two weeks later at 1 lb. per 20 sq. ft. eradicated an infestation of *Echidnophaga gallinacea* (Westw.). Some birds were still infested at the time of the second treatment, but some reinfestation may have occurred, since the pullets were let out to range between the two treatments; they were kept in after the second treatment. An experiment in which 90 hens were treated with 5 per cent. ET-57 at 12 g. each showed no difference between the hatching rates of eggs laid by them and by 90 untreated controls. No toxic effects were observed in fowls treated with ET-57 or Trithion, and no unfavourable effects on the taste of their eggs were reported.

LINDQUIST (D.A.), BURNS (E.C.), PANT (C.P.) & DAHM (P.A.). **Fate of P^{32}-labelled Bayer 21/199 in the White Rat.** — *J. econ. Ent.* **51** no. 2 pp. 204—206, 1 graph, 6 refs. Menasha, Wis., 1958.

The following is taken almost entirely from the authors' abstract. The fate of orally administered Bayer 21/199 [O,O-diethyl O-3-chloro-4-methyl-7-coumarinyl phosphorothioate], which has shown systemic activity against *Hypoderma* in cattle [*R.A.E.*, B **46** 54, 165], was studied by administration of the ^{32}P-labelled compound to white rats at an average dosage of 20 mg. per kg. body weight. The compound was rapidly metabolised and excreted. About 78 per cent. of the radioactivity of the original dose was excreted in

the urine within 24 hours. Paper chromatographic analysis indicated that the radioactivity in the urine was not due to the Bayer 21/199 but was associated with more polar compounds. Smaller amounts of radioactivity were found in the faeces, bile, lymph and blood. Among samples of various tissues taken 24 hours after dosage, small but significant amounts of radioactivity were found in bone, liver and kidney.

ALEXANDER (B.H.), BARKER (R.J.) & BABERS (F.H.). **The Phosphatase Activity of susceptible and resistant House Flies and German Cockroaches.** — *J. econ. Ent.* **51** no. 2 pp. 211—213, 9 refs. Menasha, Wis., 1958.

It has been shown that certain physiological differences found to be significant when one resistant strain is compared with one susceptible strain of an insect are not significant when several strains of each kind are compared [*cf. R.A.E.*, B **42** 74]. A possible relation between the phosphatase system and detoxification mechanism was therefore investigated and the following is virtually the author's summary of the work. Differences in the phosphatase activity of three susceptible and one DDT-resistant and one pyrethrum-resistant strain of *Musca domestica* L., a susceptible and a chlordane-resistant strain of *Blattella germanica* (L.) and a susceptible strain of *Periplaneta americana* (L.) were measured. The phosphatase analysis was based on the colorimetric determination of β-naphthol liberated from sodium β-naphtholphosphate.

Although significant differences were found in the acid and alkaline phosphatase activity between the sexes of both resistant and susceptible insects and also differences in the acid phosphatase activity between females of one DDT-resistant and one susceptible strain of insects, it was concluded that these differences were due to strain variations rather than to resistance.

GLESS (E.E.) & RAUN (E.S.). **Insecticidal Control of the Chicken Body Louse on Range Turkeys.** — *J. econ. Ent.* **51** no. 2 pp. 229—232, 4 figs., 5 refs. Menasha, Wis., 1958.

The following is partly based on the authors' abstract. After preliminary laboratory screening tests, malathion, γ BHC (lindane) and DDT were tested as emulsion sprays for the control of *Menacanthus stramineus* (Nitzsch) on flocks of range turkeys in Iowa in the autumn of 1956. Treatment was by rapid application of the sprays from a row-crop spray boom placed on the ground with the nozzles directed upwards and generally slightly forwards to give a spray curtain through which the turkeys were driven. A flock of some 2,600 turkeys could be treated in about an hour. A 1 per cent. malathion spray applied at a pressure of 60 lb. gave complete kill of lice within 24 hours, and flocks remained free of infestation for as long as three weeks, or until marketed. At a concentration of 0.5 per cent. and a pressure of 40 lb., malathion was only partly effective. A 1 per cent. concentration of γ BHC applied at 60 lb. gave complete kill within 24 hours, but the lice had re-established themselves by the 14th day after treatment, and the population had almost returned to its pretreatment level by the 29th day. DDT at 3 per cent. and a pressure of 60 lb. reduced the population but did not give complete control.

Lice were seen on all parts of the turkeys except the lower legs, feet and beak, but they were always most numerous near the vent, and visible

damage was greatest in this area. The epidermis is apparently broken during feeding, and large yellow scabs are formed from the exudate. Eggs are laid in masses at the base of the feathers, and the weight of the eggs pulls on the feather and causes inflammation. The presence of these injuries lowers the grade of the bird at market time. Lesions of treated test birds had healed sufficiently five days after treatment to allow of sale at top grade.

SULLIVAN (W.N.), DU CHANOIS (F.R.) & HAYDEN (D.L.). **Insect Survival in Jet Aircraft.** — *J. econ. Ent.* **51** no. 2 pp. 239–241, 1 fig., 1 ref. Menasha, Wis., 1958.

The following is based on the authors' abstract. To find out if insects can survive the low temperatures [*cf. R.A.E.*, B **46** 93], reduced pressure and low humidity in the stratosphere where jet aircraft operate, *Aëdes aegypti* (L.) *Musca domestica* L., *Blattella germanica* (L.), *Periplaneta americana* (L.) and *Tribolium confusum* Duv. were exposed in wire-screen cages and *Xenopsylla cheopis* (Roths.) in glass vials with cloth tops in the unpressurised and essentially unheated section of jet fighters and bombers during flights. High mortality resulted in 45- to 55-minute high-level flights of jet fighters except in the radar compartment, where heat from electronic equipment gave protection. In a jet bomber, all the insects were killed on a three-hour flight at 40,000 ft. (outside air temperature −51° C. [−59.8° F.]) and in two of three flights of 2–2½ hours at 35,000–40,000 ft. Shorter flights at that altitude or long flights at low altitudes gave reduced kills.

LOFGREN (C.S.), KELLER (J.C.) & BURDEN (G.S.). **Resistance Tests with the Bed Bug and Evaluation of Insecticides for its Control.** — *J. econ. Ent.* **51** no. 2 pp. 241–244, 5 refs. Menasha, Wis., 1958.

Resistance to DDT in *Cimex lectularius* L. has been reported from a number of countries and on occasion confirmed in the laboratory. In 1953, such resistance was demonstrated in the laboratory at Orlando, Florida, in strains of this species from Japan, Korea, Ohio and a naval vessel. In all cases, DDT had not been giving satisfactory control. The bugs were tested by exposure in petri dishes on round patches of wool cloth impregnated with a 2 per cent. solution of DDT in acetone. Exposure for 120 minutes gave complete mortality of a local strain and 90 per cent. mortality of a laboratory strain in 48 hours, but only 50 per cent. mortality of the Korean strain and none of the other three. With the same, and (in brackets) continuous, exposure to cloth impregnated with 2 per cent. solutions, γ BHC, chlordane and methoxy-DDT (methoxychlor) gave 100 (100), 40 (100) and 0 (0) per cent. kill of the Japanese strain, and dieldrin and aldrin 60 (100) and 20 (100) per cent. kill of the Ohio strain, all in 48 hours. Only 20 per cent. of Ohio bugs and 22 per cent. of those from the vessel were killed by exposure to DDT-treated cloth for one week. Continuous exposure on filter paper and glass, bearing deposits of DDT from a 1 per cent. solution in acetone at a rate of just over 0.1 ml. per sq. inch, failed to reveal any appreciable resistance in three strains of *C. lectularius* obtained from natural infestations in Denver, Colorado, in 1956. In 1957, similar continuous exposure tests with the normal colony and bugs collected from another naval vessel showed DDT at the same strength as before to have median lethal times (LT50's) of 16.1 and 39.5 and LT90's of 27.8 and 107.3 hours

for them, respectively, but the two populations showed no difference in susceptibility to γ BHC at one-twentieth the strength of the DDT.

The lasting effectiveness of 11 insecticides was then determined by exposure of normal adults of *C. lectularius* that had been starved for three days, which had been shown in the previous tests to be more susceptible to DDT than those exposed on the first day after feeding, to cloth patches 1½ in. in diameter treated with 0.7 ml. of 0.4 per cent. acetone solutions. Malathion, Am. Cyanamid 4124 [O,O-dimethyl O-2-chloro-4-nitrophenyl phosphorothioate] and 0.4 per cent. pyrethrins with 4 per cent. piperonyl butoxide were effective for the longest periods, giving complete or almost complete kill in 24 hours with two hours' exposure for 24, 16 and 28 weeks (the maximum tested), respectively. Of eight insecticides tested on natural infestations in sub-standard hotels in Denver by application in kerosene solution with a compressed-air sprayer to bed frames, mattresses and woodwork, diazinon [O,O-diethyl O-2-isopropyl-4-methyl-6-pyrimidinyl phosphorothioate] gave the most rapid control, no bugs being found throughout 11 days of observation after treatment with a 0.5 per cent. solution. Dow ET-57 [O,O-dimethyl O-2,4,5-trichlorophenyl phosphorothioate], Dipterex [dimethyl 2,2,2-trichloro-1-hydroxyethylphosphonate], Chlorthion [O,O-dimethyl O-3-chloro-4-nitrophenyl phosphorothioate], malathion and dieldrin at the same strength gave complete control in 2–8 days, but 5 per cent. DDT was slower in action. Pyrethrins at 0.1 per cent. with 1 per cent. piperonyl butoxide gave complete control in two days, but newly hatched nymphs were present after one week. In tests in houses in Orlando, one living bug was found two days after treatment in each of two homes in which malathion was used and in two of five treated with Am. Cyanamid 4124, but none was found in any of the homes during the remainder of the inspection period of nine months.

GOODHUE (L.D.) & CANTREL (K.E.). **The Use of Vermiculite in Medium for Stable Fly Larvae.** — *J. econ. Ent.* **51** no. 2 p. 250, 4 refs. Menasha, Wis., 1958.

Various workers have used the CSMA medium, sometimes with modifications, for rearing *Stomoxys calcitrans* (L.) [*cf. R.A.E.*, B **44** 72, etc.]. The authors obtained improved results by adding vermiculite [*cf.* **47** 13] to the standard medium. A mixture of 3,892 ml. water, 232 ml. 20 per cent. yeast suspension, 32 ml. Diamalt and 1,828 g. medium is blended with one of 400 g. vermiculite and 2,000 ml. water. This is divided between five flat crocks of 1 U.S. gal. capacity, which are more satisfactory than deeper cylindrical ones, and each crock is seeded with 0.6 ml. washed eggs and covered with muslin. After storage at 80°F. for 12 days nearly all the larvae will have pupated and the pupae are cleaned by an air separator [**38** 210]. Emergence begins on the 14th day.

JOHNSON (W.T.). **Tests with Malathion for Hog Lice Control.** — *J. econ. Ent.* **51** no. 2 pp. 255–256, Menasha, Wis., 1958.

In tests in Maryland of the effectiveness of malathion against *Haematopinus suis* (L.), three lots of four pigs with average weights of 90 lb. were treated by means of a compressed-air sprayer with about 475 ml. per animal of an emulsion containing malathion at 0.5, 0.25 and 0.1 per cent., respectively, and four were kept as untreated controls. No adult lice or eggs were found after nine days on any of the pigs receiving the two higher concen-

trations, but after 3—5 days some of the pigs were infested with adults, and all that were clean enough for accurate records to be made bore eggs. Lice and eggs were found after nine days on two of the four pigs receiving the lowest concentration. Gross observations of a herd of pigs sprayed once with 1 per cent. malathion indicated that control was complete for more than 30 days. Two pigs were sprayed with 650 ml. 1 per cent. malathion emulsion and one week later with 750 ml. and slaughtered three days after the second treatment. The fat, lean meat and liver were analysed in two laboratories, and no malathion or practically none was recovered. It is concluded that malathion is effective for the control of *H. suis* and safe for use on animals being prepared for slaughter.

HAYS (K.L.) & GUYTON (F.E.). **Parasitic Mites (Acarina: Mesostigmata) from Alabama Mammals.** — *J. econ. Ent.* **51** no. 2 pp. 259—260. Menasha, Wis., 1958.

In 1953 and 1954, 157 out of 259 small mammals of 30 species collected in Lee County, east-central Alabama, were found to be infested with mesostigmatic mites, belonging to 13 species. A list is given of the mammals and the species and average number of mites found on each.

CRAIG (J.G.O.), RAI (L.) & ROAN (C.C.). **The Effects of Piperonyl Butoxide on the Mode of Action of Malathion in Cockroaches.** — *J. Kans. ent. Soc.* **30** no. 4 pp. 153—155, 5 refs. Manhattan, Kans., 1957.

The effect of piperonyl butoxide on the toxicity of malathion [*cf. R.A.E.*, B **45** 111—112, 172; **47** 13—14] to males of *Blattella germanica* (L.) and *Leucophaea maderae* (F.) was tested by topical application of acetone solutions. Six dosages of malathion (0.21—2.14 μg. per cockroach) were applied to the mesosternum of *B. germanica* and four (50—100 μg.) to the centre of the abdominal tergites of *L. maderae*, in each case alone or with the addition of ten times as much piperonyl butoxide, and mortality was noted after 24 hours. The presence of piperonyl butoxide increased the percentage mortality of *B. germanica* caused by all dosages of malathion except the lowest, whereas it decreased the percentage mortality of *L. maderae* at all rates. The dosages that gave 50 per cent. mortality of *B. germanica* and *L. maderae* gave, respectively, 66 and 30 per cent. in the presence of piperonyl butoxide. The median lethal doses of malathion alone and in combination with piperonyl butoxide were calculated to be 89.4 and 67.1 μg. per g. body weight, respectively, for *B. germanica* and 271.6 and 521.3 μg. per g. for *L. maderae*. The reason for the difference in effect on the two species is not known.

WANG (Hsing-hsiang) & CHANG (Chun). **The outdoor nocturnal biting Activity of *Anopheles hyrcanus* var. *sinensis* in Relation to the Factors of Temperature, Humidity, Light and Rain.** [*In Chinese.*] — *Acta ent. sin.* 7 no. 4 pp. 473—480, 5 graphs, 4 refs. [Peking] 1957. (With a Summary in English.)

By means of five-minute catches made six times an hour from sunset to sunrise on 17 nights from June to September 1956, it was found that *Anopheles hyrcanus sinensis* Wied. came throughout the night to bite a buffalo in a field in the area of Loshan (Szechwan). There was a peak in biting

activity in the evening and another at dawn. Activity was increased on moonlit nights, if temperature was above 23–25° C. [73.4–77° F.], and might be prevented by heavy rain, but was increased by light rain.

LEE (La-ge). **Preliminary Observations on the Effect of DDT indoor Treatment on *Anonpheles hyrcanus* var. *sinensis* and *Anopheles jeyporiensis* var. *candidiensis*.** [*In Chinese.*] — *Acta ent. sin.* **7** no. 4 pp. 481–488, 3 figs., 13 refs. [Peking] 1957. (With a Summary in English.)

The effect of house spraying with DDT on *Anopheles hyrcanus sinensis* Wied. and *A. jeyporiensis candidiensis* Koidz., which rest outdoors and indoors, respectively, was studied in the Chung-hua district of Kwangtung Province. Window-trap catches in treated premises showed that about 90 per cent. of the adults of both were still alive after 24 hours and over 60 per cent. were alive and 50 per cent. able to breed and oviposit after 72 hours. The treatment had an excito-repellent effect on both species which prevented their picking up a lethal dose.

CHANG (Teng-heao). **Further Studies on the Hibernation of Mosquitoes in Changsha, Hunan (January to March, 1956).** [*In Chinese.*] — *Acta ent. sin.* **7** no. 4 pp. 501–510, 1 fig., 8 refs. [Peking] 1957. (With a Summary in English.)

Tree holes, bamboo stumps, jars, earthen pots, fertiliser pits containing faeces, basements, greenhouses and mountain caves in Changsha (Hunan) were searched weekly for mosquitoes from January to March 1956, and seven species were found either in the adult or an immature stage. Eggs of *Aëdes albopictus* (Skuse) and *A. niveus* (Ludl.) were found in tree holes and those of the former in artificial containers and bamboo stumps also. The larvae of *Orthopodomyia anopheloides* (Giles) were found in tree holes and of *Armigeres obturbans* (Wlk.) under vegetable débris in water in faecal pits. Females of *Anopheles hyrcanus sinensis* Wied. and both sexes of *C. pipiens fatigans* Wied. were caught overwintering in mountain caves, and the latter in greenhouses and basements as well.

YOELI (M.). **The Problem of Filariasis among Indian Jews in Israel.** — *Trans. R. Soc. trop. Med. Hyg.* **51** no. 2 pp. 125–131, 1 map, 4 refs. London, 1957.

Among Indian Jewish immigrants to Israel from the State of Kerala (Travancore-Cochin) and their children, 102 of 878 examined between July 1955 and May 1956 were found to carry microfilariae of *Wuchereria bancrofti* in the nocturnal peripheral blood [*cf. R.A.E.*, B **27** 44; **46** 147, 200]. Most of these immigrants arrived during 1953–56; no infection was found among the 19 infants examined, under two years old and born in Israel, and the youngest carrier was 2½ years old. The prevalence and distribution of infection among the immigrants in different settlements reflected the conditions in their previous place of residence in India.

Where the immigrants lived in homogeneous communities, they kept up some habits (such as closing the windows from sunset till late in the morning, sleeping uncovered and in overcrowded quarters, rubbing the body with fats and oils and cooking until late at night) that tended to produce high indoor temperatures and humidities and favour the transmission of

filariasis.

Of 23, 13 and 72 females of *Culex pipiens molestus* Forsk. caught in June 1955, July 1955 and April 1956 in the houses of such settlers in a village in the hills between Jerusalem and Tel-Aviv, an immigrant camp near Haifa and a settlement in the coastal plain between Haifa and Jerusalem, respectively, 2, 1 and 0 were infected with developing larvae of *W. bancrofti*. In three experiments in 1955 in which laboratory-bred females of a local strain of *C. p. molestus* were fed on carriers with 274, 18 and 12 microfilariae per 20 cu. mm. peripheral blood, respectively, 65, 86.9 and 82.3 per cent. of 40, 38 and 34 dissected contained developing larvae many of which were infective. Mortality in the first group, fed on the more highly infected blood, was 41 per cent. in 18 days, as compared with 9.5 per cent. in the second. Blood examinations were carried out at night in two collective settlements in the coastal plain that had admitted Indian immigrants 2–5 years earlier and were heavily infested with DDT-resistant *C. p. molestus*. No carriers of *W. bancrofti* were found among the 619 European settlers, but there was a rate of 14 per cent. among the Indians. Similarly, in 1954, R. Reitler & Y. Yoffe had found no infection in 101 Europeans, but 12 carriers among 107 Indian immigrants who had lived with them under primitive conditions for two years in an area where mosquitoes were abundant. It is concluded that the chances of transmission of *W. bancrofti* under conditions prevailing in modern settlements in Israel are small, but there may be some local sporadic infections in homogeneous settlements of Indian Jews who have kept their old ways of life and do not carry out anti-mosquito and anti-filarial measures.

DRAPER (C.C.) & SMITH (A.). **Malaria in the Pare Area of N. E. Tanganyika. Part I: Epidemiology.** — *Trans. R. Soc. trop. Med. Hyg.* **51** no. 2 pp. 137–151, 1 map, 18 refs. London, 1957.

The observations described were made in 1954–56 at the foot of the South Pare mountains in north-eastern Tanganyika, about 100 miles from the coast. The population is concentrated along the foot of the mountains, from which several streams and rivers, providing water for irrigation, flow into the Mkomazi river; this has along its course a number of permanent swamps, but the largest villages lie at intervals along the main road a mile or more from the swamps and main irrigation areas, and there are small scattered hamlets in the latter. Large numbers of cattle, which graze in the grasslands by day and are penned in enclosures near the huts at night, are kept, chiefly in the hamlets, and in the roadside villages a few are sometimes tethered at night near the huts. The average annual rainfall for 1936–54 was 34 in., but about 17 in. fell in 1954 and 52 in. in 1955. The seasonal distribution of rainfall varies somewhat from year to year, but there is usually rain in October, November and December.

The chief vectors of malaria are *Anopheles gambiae* Giles, which breeds mainly in the rice-fields and irrigation channels, and *A. funestus* Giles, which breeds mainly in the swamps. One female of *A. pharoensis* Theo., 500 dissected, was infected with sporozoites, but these were not necessarily derived from man; this species was occasionally found resting in huts and on the walls of cattle enclosures.

Monthly catches between October 1954 and September 1955 in 150 huts scattered throughout the villages and hamlets showed that populations of *A. gambiae* began to build up after the rains in November and December and reached their maximum in the following months, which formed the chief irrigation period and during which there was also more rain. *A. funestus*

was most abundant from April to August and was prevalent especially in those villages nearest the permanent swamps. On the basis of Gillies' findings near the coast [*R.A.E.*, B **42** 113] and the temperature data for South Pare, it was estimated that *A. gambiae* and *A. funestus* would have 48-hour gonotrophic cycles from October to April and from October to March inclusive, respectively, and this was confirmed by analysis of the ovarian stages of females of both species, caught in houses in January and February 1955.

There was an exodus of half-gravid females from the huts, similar to that observed at the coast [**42** 119; **43** 62], but the proportion of unfed females found resting in huts and the exodus of recently fed ones were greater. The results of nearly 5,000 precipitin tests showed that over 90 per cent. of hut-resting females of *A. gambiae* and *A. funestus* had fed on man or cattle. The presence of cattle-fed females in huts was presumably attributable to the paucity of outside resting places. The extent to which *A. gambiae* feeds on man varies with the proximity of cattle to huts, and was greater in the roadside villages, but nearly all females of *A. funestus* had fed on man, whether animals were available or not. Large numbers of *A. gambiae* rest outside [*cf.* **46** 205], and many of those doing so have just fed, mostly on cattle. Collection of mosquitoes biting out of doors for two hours at dusk on five consecutive nights a month for a year showed that most biting by *A. gambiae* under these conditions occurred in December, when the average caught was 27 per man per night. The number decreased to five in January, rose to 13 in March, and then fell until October, when none was caught. Catches of *A. funestus* were always low, but exceeded those of *A. gambiae* between April and August.

Sporozoite rates among females of *A. gambiae* and (in brackets) *A. funestus* caught from October 1954 to September 1955 in huts were 0.5 (0.28) in the roadside villages and 0.31 (0.54) in the swamp villages. The differences between swamp and roadside villages, though suggestive, are not statistically significant. The lowness of these rates compared with those in coastal areas [**43** 72] and in some other inland areas of East Africa [**24** 193] was regarded, in the case of *A. gambiae*, as being due to the large numbers of this species that feed on cattle and to a lower natural survival caused by the arid climate, but the last must be considered to be the chief factor in the case of *A. funestus* since this species does not feed much on cattle. It was calculated from the entomological data for a group of representative villages that each member of the population would receive about 13—27 infective bites in a year (11—22 from *A. gambiae* and 1—10 from *A. funestus*) in the roadside villages and 27—53 (10—15 and 26—40) in swamp villages. Although *A. gambiae* is more numerous in the swamp hamlets than in the roadside villages and its season is longer, these factors are more than offset by greater deviation to cattle and lower sporozoite rates and it is comparatively unimportant in them. As densities of *A. funestus* remain high throughout the drier months in the swamp hamlets, malaria transmission is perennial, with little seasonal variation.

Spleen and parasite rates confirm the greater intensity of malaria in the swamp than in the roadside villages and the slight seasonal variation in the former. Malaria indices in children are generally lower and reach their peaks later than on the coast, while the spleen rate and the size of enlarged spleens remain high in adult life. These trends suggest high endemicity without the acquisition of such strong immunity as is seen on the coast and elsewhere. The observed infant parasite rates, in swamp and roadside villages combined, necessitate a successful inoculation rate of about one a year. As in areas of higher transmission in which similar analyses have been made [**43** 62; **45** 49], this inoculation rate is

considerably lower than that calculated from the entomological data, but the discrepancy is not so great.

RAFI (S.M.), RASHID (M.) & SHOREY (W.U.). **Malaria Survey of Border Area of Baluchistan adjacent to Iran.** — *Pakist. J. Hlth* **6** no. 4 pp. 233–242, 1 map, 4 refs. Lahore, 1957.

A malaria survey of the parts of Baluchistan bordering on Persia was undertaken in March and April 1957. The belt surveyed included highland, plain and desert areas. Seven species of *Anonpheles*, collected from dwellings and cattle sheds, included *A. culicifacies* Giles, *A. fluviatilis* James, *A. stephensi* List., *A. subpictus* Grassi, *A. pulcherrimus* Theo. and *A. turkhudi* List. [*cf. R.A.E.*, B **44** 141; **45** 198–199]. Larvae of *A. culicifacies* and *A. dthali* Patt. were found in pools in a river-bed and in a borrowpit. The spleen and parasite rates in children 2–10 years old varied in different villages from 0 to 57.7 and from 0 to 23.1 per cent., respectively. In the part of the area lying in Chagai district, which is hilly and sandy, the spleen and parasite rates were only 6.9 and 10 per cent. The central part, lying in Kharan district, was moderately malarious with a spleen rate of 38.5 per cent., and in Mekran district in the south, the spleen rate varied from 7.7 to 57.7 per cent. The incidence of the disease in patients attending dispensaries tended to rise in August each year after the rains and remain high until December.

THOMSON (R.C. Muirhead-). **Effect of Desiccation on the Eggs of *Simulium damnosum*, Theobald.** — *Nature* **180** no. 4599 pp. 1432–1433, 3 refs. London, 1957.

Many of the smaller rivers in the savannah areas of West Africa, in which *Simulium damnosum* Theo. breeds in the rainy season, may dry up or be reduced to stagnant pools in the long dry season, and the stage or condition in which the insect passes this season has been a matter for discussion [*R.A.E.*, B **45** 192]. As larvae appear very soon after the rivers start to flow again, survival in the egg stage with the eggs lying dormant in the dried mud or sand was long thought likely, but as *S. damnosum* is very refractory in captivity and as its oviposition sites and habits in West Africa were unknown until recently, direct observation was not possible. Crisp [*loc. cit.*] found that eggs taken from natural oviposition sites and dried out could survive exposure to direct sunlight for 40 minutes, but the proportion hatching decreased with lengthened exposure and no eggs left in the sun for 12 hours hatched; he concluded that survival of eggs through the dry season seemed unlikely.

The author observed oviposition in Liberia [**45** 90–91] in an area in which breeding continues throughout the year in perennial streams, and he sometimes obtained large batches of eggs. To study the reactions of these eggs to desiccation, leaves with many thousands attached were divided into portions and allowed to dry for different periods at 27–28° C. [80.6–82.4° F.] and about 70–95 per cent. relative humidity, in a shaded part of the laboratory. The portions of leaf were then suspended in contact with aerated water, in conditions that always allowed all the untreated controls to hatch. All those dried for periods up to 18 hours hatched, but virtually none of those dried for 24 hours or more did so. The conditions of exposure were much less severe than those used by Crisp or those normally to be found in a dry watercourse, so that the results indicate that the eggs have no marked ability to withstand even comparatively short periods of desiccation.

GRAHAM (O.H.), WADE (L.L.), COLBY (R.W.) & MCGREGOR (W.S.). **Use of Dow ET-57 for the Systemic Control of *Dermatobia hominis* in Cattle.** — *Agric. Chem.* **12** no. 10 pp. 51, 109, 4 refs. Baltimore, Md., 1957.

In tests carried out in the Republic of Panama in July and October 1956, one dose of Dow ET-57 [purified O,O-dimethyl O-2,4,5-trichlorophenyl phosphorothioate], administered orally as a drench prepared from a wettable powder at 100 mg. per kg. body weight to cattle infested with larvae of *Dermatobia hominis* (L. jr.), gave an average kill of 72.6 per cent. This dosage is effective against *Hypoderma* [*R.A.E.*, B **46** 89]. At 150 mg. per kg., kill was 81.3 per cent. The young larvae were very susceptible, and all survivors were in a comparatively advanced stage of development. No toxic effects were noted in any of the treated animals.

MURRAY (M.D.). **The Distribution of the Eggs of Mammalian Lice on their Hosts. I. Description of the Oviposition Behaviour.** — *Aust. J. Zool.* **5** no. 1 pp. 13–18, 2 figs., 2 refs. Melbourne, 1957. **II. Analysis of the Oviposition Behaviour of *Damalinia ovis* (L.).** — *T.c.* pp. 19–29, 5 graphs, 5 refs. **III. The Distribution of the Eggs of *Damalinia ovis* (L.) on the Sheep.** — *T.c.* no. 2 pp. 173–182, 6 figs., 12 refs. **IV. The Distribution of the Eggs of *Damalinia equi* (Denny) and *Haematopinus asini* (L.) on the Horse.** — *T.c.* pp. 183–187, 1 pl., 1 graph, 6 refs.

The following paragraphs are partly based on the author's summaries of the four parts of this series, in which some of the factors that determine the disposition of the eggs of lice in the hair of mammalian hosts are discussed.

The microclimate in sheep fleece was measured by means of a group of thermocouples ensheathed in hypodermic needles; this was inserted into the fleece and the needle sheaths withdrawn for readings. At an atmospheric temperature of 24.5° C. [76.1° F.], there was a gradient from 37.5±1° C. [99.5±1.8° F.] next to the skin (measured by individual fine thermocouples) to near atmospheric temperature at the tip of a 1-inch fleece. Oviposition behaviour in *Damalinia ovis* (Schr.), the biting louse of sheep, and *Linognathus stenopis* (Durm.) and *Haematopinus eurysternus* (Nitzsch), sucking lice from goats and cattle, respectively, were compared in laboratory experiments in which the lice were exposed on the hair of the host to a temperature gradient of 19 to 43° C. [66.2 to 109.4° F.] in an apparatus that is described. The behaviour of the three species was similar and three stages were recognisable. The louse first sought the warm end of the gradient; it then remained stationary for a variable period with its head towards the warm end; finally it turned suddenly about, grasped a fibre against its abdomen with its gonopods and excreted cement on to the fibre, sometimes after backing towards the warmth; the egg was deposited as the cement was hardening. Eggs were consequently aligned similarly, with the end of attachment to the fibre nearest to the warm end of the temperature gradient. This position resembled that found naturally and suggests that the behaviour patterns of the lice are adapted to common physical characteristics of the environment, notably a temperature gradient.

Experiments with *D. ovis* showed that the physical characteristics of the fibres but not the chemical ones influenced oviposition behaviour. Eggs were laid on synthetic fibres as readily as on natural ones, but were laid freely only on those of diameters of 0.02 mm. or less, and the presence of a fibre of such diameter that it could be held next to the abdomen by a gonopod was necessary for egg-laying. In the first stage of oviposition

behaviour, the louse was attracted to temperatures between 35 and 40° C. [95 and 104° F.], and temperatures in this zone were necessary for oviposition to proceed satisfactorily, conditions being optimum between 37 and 39° C. [98.6 and 102.2° F.]. In the second stage, the louse orientated itself in temperature or humidity gradients with its head towards the warm or saturated end, but when the gradients were antagonistic, orientation to temperature dominated. At the beginning of stage three, the louse reversed its orientation in both temperature and humidity gradients, and again the influence of temperature was dominant. At 37.5° C., fewer eggs were laid at relative humidities of 95 and 20 per cent. than at one of 60 per cent. and in the shaded half of a cell than in the half exposed to daylight; these effects were also subordinate to temperature. The presence of other ovipositing lice and eggs was attractive.

Eggs may be laid at different distances from the skin of the host (vertical distribution) and on different parts of the body (lateral distribution). The vertical distribution of the newly laid eggs of *D. ovis* was shown to be determined by the distance to which the temperature zone suitable for oviposition extends from the skin. This is regulated mainly by skin temperature, skin folds, the depth of the air blanket trapped within the fleece and atmospheric temperature. Usually, the eggs are laid within ¼ in. of the skin. When the temperature gradient in the fleece is reversed, as by exposure to the sun, the lice are driven into the zone near the skin, where the only suitable temperatures are to be found. The factors that influence lateral distribution are the presence of suitable fibres and temperatures for oviposition. Eggs are not laid on bare areas on the body, but there are few such on sheep. The bases of certain hairs on the face and legs and in the axilla and inguinal regions are too thick for oviposition, but there are many suitable fibres among them. As there are no areas on the sheep that are entirely covered with hairs of unsuitable size, fibre diameter has little influence on the lateral distribution of eggs. When sheep were exposed to an atmospheric temperature of 10° C. [50° F.], the skin temperature of the extremities fell below that at which *D. ovis* can oviposit. Skin temperature is the main factor determining lateral distribution.

The two species of lice found on horses are the biting louse, *D. equi* (Denny), and the sucking louse, *Haematopinus asini* (L.). The eggs of both are attached to the hairs close to the skin, with the end of attachment nearest to it. The oviposition behaviour of *D. equi* was found to be similar to that of *D. ovis*. The only observable difference is that the gonopods are not used at the time of egg-laying, the fibre being grasped by the claspers. Temperatures of 32–38° C. [89.6–100.4° F.] were required for the maximum number of lice in a population to oviposit, and any lowering of the skin temperature of the extremities below 30° C. would influence the lateral distribution of the eggs. A fibre of suitable diameter is also necessary; *D. equi* cannot attach its eggs to the coarse hairs of the face, mane, tail and legs, whereas *H. asini* can do so. As the coarse hairs are not shed with the fine hairs of the coat at the beginning of summer and winter, the shedding of the coat reduces a population of *D. equi* more than one of *H. asini*.

STONE (B.F.) & MEYERS (R.A.J.). **Dieldrin-resistant Cattle Ticks, *Boophilus microplus* (Canestrini), in Queensland.** — *Aust. J. agric. Res.* **8** no. 3 pp. 312–317, 14 refs. Melbourne, 1957.

In Australia, evidence of dieldrin-resistance in strains of *Boophilus microplus* (Can.) resistant to γ BHC and toxaphene has been obtained

in the laboratory [*cf. R.A.E.*, D **42** 79; **46** 87–88]. It is now recorded that, in 1955, spraying with 0.05 per cent. w/v dieldrin in emulsified solution twice in November failed to control the ticks in a herd of cattle near Brisbane although two applications in May and June were reported to have been satisfactory; later in November a 0.05 per cent. suspension of γ BHC was also ineffective, but 0.08 per cent. w/v diazinon [O,O-diethyl O-2-isopropyl-4-methyl-6-pyrimidinyl phosphorothioate] readily controlled the ticks; after a further two weeks, excellent results were obtained by using this at 0.05 per cent., and continued application at this rate, at intervals of three weeks, kept the cattle free of injurious infestations for the remainder of the season. A steer that had been infested with a culture of larvae from the Brisbane ticks was sprayed with a 0.05 per cent. colloidal suspension of dieldrin when engorged females were beginning to fall from it; 98 per cent. of the females that fell in the next 48 hours laid normal batches of viable eggs, whereas no females of a normal strain picked from cattle similarly treated did so. Laboratory dipping tests with a culture of the dieldrin-resistant larvae showed the median lethal concentration of dieldrin in colloidal suspension to be over 2,000 times that for larvae of a normal strain, and the engorged adult females also proved highly resistant. There was some evidence that the ticks might have already developed some resistance to γ BHC when the dieldrin sprays were adopted. Whether the dieldrin-resistance was complex or simple in origin, it developed extremely rapidly.

VERCAMMEN-GRANDJEAN (P.H.). **Une technique pour l'obtention des nymphes de Trombiculidae à partir des larves gorgées.** — *Ann. Parasit. hum.comp.* **32** no. 4 pp. 450–451, 1 fig. Paris, 1957.

Since 1954, the author has successfully reared Trombiculid nymphs from engorged larvae on pads of filter paper in glass cells 16 mm. in diameter. The pads, of several layers of paper, measure 5 mm. in diameter and 1 mm. in thickness and are moistened with distilled water until the surface glistens. Six engorged larvae more or less immobilised by floating on water for 12 hours are put on the pad, and the whole is protected by a cover-slip. The edges of the slip are smeared with vaseline except for a 2-mm. gap left to prevent the development of excess of pressure. Loss of water by evaporation is negligible, but should any occur, the cover-slip can be slid to one side and water added to the lower edge of the pad with a fine pipette. The larvae are prevented from leaving the pad by the water meniscus at its base. Day-to-day progress can be followed with a stereoscopic lens, and even if the cover-slip becomes somewhat misted, life can easily be detected with combined direct and transparent lighting. When plaster [*cf. R.A.E.*, B **47** 89] 1.5 mm. thick was used in the same glass containers, identical results were obtained, but the plaster blackened with age and had to be destroyed and replaced, a much more complicated procedure than was involved in the use of the filter-paper pads, which were clean, cheap and convenient.

GALUN (R.) & FRAENKEL (G.). **Physiological Effects of Carbohydrates in the Nutrition of a Mosquito, *Aëdes aegypti* and two flies, *Sarcophaga bullata* and *Musca domestica*.** — *J. cell. comp. Physiol.* **50** no. 1 pp. 1–23, 1 graph, 16 refs. Philadelphia, Pa., 1957.

The following is largely based on the authors' summary. The utilisation

of 28 carbohydrates by the adults of *Aëdes aegypti* (L.), *Sarcophaga bullata* Parker and *Musca domestica* L. was investigated, and the findings, which are described in detail, reflected to some extent the natural feeding habits of the three insects. Enzymatic changes were shown to occur during larval and pupal development. Attempts were made to distinguish which of the non-nutritive carbohydrates were inert, toxic or repellent by comparing the survival times and the amounts consumed when the insects were offered solutions of sucrose alone or sucrose with another carbohydrate [*cf. R.A.E.*, B **46** 175]. Xylose, arabinose, ribose, rhamnose, sorbose, *α*-methylmannoside and inositol were found to have a strong repellent effect on *M. domestica*, and to be toxic as well. Dulcitol was completely inert in both respects. All the above compounds were, to some degree, toxic or repellent or perhaps both for *A. aegypti* and *S. bullata* also, except that the last insect was practically unaffected by inositol. The small amounts consumed by the mosquito did not allow of separation of the two effects by the methods used. Only arabinose was tested quantitatively with *S. bullata* and was both repellent and toxic to some extent.

GARRETT-JONES (C.). **Migratory Flight in Anopheline Mosquitos in the Middle East.** — *Bull. endemic Dis.* **2** no. 1–2 pp. 79–87, 11 refs. Baghdad, 1957.

Migratory flight in mosquitos is here defined as an irreversible flight by fertile females, confined to a regular but short season, not entirely involuntary (though it may be wind-aided), and serving the function rather of dispersion than of feeding. It may or may not be followed by adult hibernation. *Anopheles maculipennis sacharovi* Favr. has long been known to make such flights, and the females have been found hibernating in buildings in northern Israel nearly nine miles from the nearest breeding places [*R.A.E.*, B **19** 123; **20** 193]. They arrive in their winter quarters in October or November and leave in April. In Lebanon and Syria, some localities in which overwintering occurs are entirely free of this mosquito throughout the breeding season (April–October) and no males are found in them. Between December 1952 and January 1954, evidence of similar flight in three other species of *Anopheles* were provided by a survey of two hill villages (Dedde and Deir Bille), in northern Labanon, that were typical of those in which low malaria endemicity persisted in the absence of surface water during the six summer months. The summer water supply of these villages comes from underground rainwater reservoirs excavated in the limestone rock and usually lined with cement. *A. claviger* (Mg.) breeds in these in abundance almost throughout the year and has hitherto been assumed to be responsible for the malaria, as no other species breeds in them. Because, however, *A. claviger* breeds in shady surface waters also, it appears in virtually all the villages of the Lebanon at some season, and migratory flight in it could therefore be conclusively demonstrated only by the recapture of marked individuals. Mating in the underground reservoirs was observed at almost all seasons. From January to August 1953, the females left the reservoirs in the afternoon to feed and returned to them before nightfall [*cf.* **46** 216], so that they were rarely found in houses or animal quarters into which, however, an influx was observed in the autumn. There was no obvious corresponding decrease in the numbers of adults resting inside the reservoirs, and it was not known whether the autumn influx could be ascribed to these or to a migration from sylvatic breeding places ½–2 miles away. Females of *A. superpictus* Grassi were found in buildings in Dedde in October, November and December, [*cf.* **46** 216], but not from January to

September, and several were found in a cattle-shed in Deir Dille in March, none in the following three months but increasing numbers thereafter until October. Men and cattle were available much nearer the local breeding places than were the villages, so that these observations indicate migratory flight. Eight females of *A. marteri* Sen. & Prun., which breeds in running streams, were taken in a goat-shed at Deir Dille, to which they had presumably flown more than half a mile from the river, surmounting a cliff 600 ft. high. One female was caught in a window trap in June at Dedde, which was about two miles from the river. *A. sergentii* (Theo.) was seen from late July to November only, and two females taken in houses in October at Dedde must also have travelled at least two miles [*cf.* **43** 172; **46** 217]. Thus, migration has been demonstrated in four of the species recorded from Lebanon and western Syria, and possibly also in *A. claviger*.

It is pointed out that for one migrant individual to be recovered in such a survey, many hundreds must in fact have travelled a similar distance. Such individuals, caught and identified at unusual distances from their breeding place, are therefore a strong indication of mass movement across the intervening country. In an arid region such as the Middle East, the breeding of any species of mosquito is likely to be geographically discontinuous, and a long irreversible flight is of value in extending its range and repopulating breeding places that had been rendered temporarily unfavourable by prolonged drought or flooding. Mosquitos that possess no gene for migratory flight would probably tend to become extinct or highly localised and to be displaced by more successful types, both within a species and between competitive species. Such flights may therefore prove to be prevalent in the Anophelines of the area.

COLLESS (D.H.). **Components of the Catch Curve of *Culex annulus* in Singapore.** — *Nature* **180** no. 4600 pp. 1496–1497, 2 graphs, 3 refs. London, 1957.

In discussing the biting cycle of *Anopheles leucosphyrus* Dön. in Borneo, the author suggested that mosquitos reach their food by a process of random wandering, or at least not as a result of orientation by the host itself [*R.A.E.*, B **46** 112]. In subsequent observations on *Culex annulus* Theo. in Singapore, it was found that the mean hourly catches of mosquitos of this species arriving in a stable containing a horse fell steadily throughout the night from 11.3 to 4, and the observed catches agreed closely with those to be expected if flight was random, assuming the initial distribution of the mosquitos to have been fairly uniform and activation to flight more or less immediate upon the onset of darkness. If this was so, the steady fall in the numbers arriving throughout the night represented nothing more than the depletion of the unfed population by their fixation at the host. In Singapore most species of *Culex* [**46** 178] and *Mansonia* show a biting cycle of the general type described here, and it seems probably that the biting cycles of most mosquitos include a depletion curve as one component.

TWOHY (D.W.) & ROZEBOOM (L.E.). **A Comparison of Food Reserves in autogenous and anautogenous *Culex pipiens* Populations.** — *Amer. J. Hyg.* **65** no. 3 pp. 316–324, 2 graphs, 15 refs. Baltimore, Md., 1957.

The following is substantially the authors' summary of a comparison of food reserves in females of *Culex pipiens molestus* Forsk. and *C. p. pipiens* L.

studied in laboratory-bred colonies established from Maryland material. Under similar conditions of environment and nutrition, larvae of *molestus* needed slightly longer to complete their development and gave rise to larger adults than did those of typical *pipiens*. The female pupae and adults of *molestus* contained larger amounts of lipids, glycogen and nitrogen, and higher proportions of the first two but lower of the third, than did those of *pipiens*. The rates of utilisation of these components was the same in the two forms. By the time that unfed females of *molestus* lay their autogenous eggs, females of *pipiens* have used all their lipid and glycogen reserves, and this may preclude the formation of more than a small amount of yolk by *pipiens* [*cf.* next abstract]. The larger reserves in *molestus* supply an adequate amount of material for the developing ovaries and allow the females to survive through the gestation period. However, it is evident that the greater reserves accumulated by *molestus* are not the result of environment, but of an inherent physiological mechanism [*cf. R.A.E.*, B **45** 103].

SPIELMAN (A.). **The Inheritance of Autogeny in the *Culex pipiens* Complex of Mosquitoes.** — *Amer. J. Hyg.* **65** no. 3 pp. 404–425, 9 graphs, 39 refs. Baltimore, Md., 1957.

The work described was carried out to determine the pattern of inheritance of autogeny in some laboratory populations of the complex of *Culex pipiens* L., as a preliminary to an understanding of the distribution of factors for this character in a wild population. The material used belonged to an autogenous colony that was morphologically typical of *C. p. pipiens* on the basis of the DV/D ratio [*R.A.E.*, B **40** 187] but could be considered *C. p. molestus* Forsk. in the usage of Marshall & Staley [**25** 136; *cf.* also **41** 119, etc.], and two anautogenous colonies, one of *C. p. pipiens* originating from Maryland, and another of *C. p. fatigans* Wied. (*quinquefasciatus* auct.) originating from Alabama; a strain of the latter from Texas was used in one crossing experiment. More than 500 unfed females from anautogenous colonies were isolated and examined for egg formation. None produced eggs, nor did any produce enough yolk to pack the oocyte [*cf.* previous abstract]. Cessation of ovarian development at this point is regarded as an ovarian diapause. Of 162 females of the autogenous colony, 99.4 per cent. showed ovarian development beyond the diapause stage, and 95.7 per cent. completed the formation of eggs. Chilling at 40° F. halted ovarian development, but process was reversible, and development was resumed with the return of normal temperatures after chilling for 4–12 days. Autogenous females did not pass the diapause stage until they had been adult for 35 hours. They contained mature eggs after 75 hours and oviposited after 100 hours. When the larvae were reared under such unfavourable conditions of feeding and overcrowding that the wing length of the ensuing females fell to 3 mm. and below, autogeny was reduced. Autogenous development was shown by all of 108 females from the autogenous colony, although 53 of them were denied access to males, but fewer eggs were laid by virgin females and fewer of these eggs were formed into rafts. The taking of a blood-meal by a female of an autogenous strain did not affect the autogenous potential of the progeny.

The inheritance of autogeny was investigated by means of a series of seven pairs of reciprocal crosses and back-crosses between adults from the autogenous colony and one or other of the anautogenous colonies. For each hybrid population, the percentage of females, derived from uncrowded pupae, that passed the diapause stage and that contained mature eggs was determined and the mean number of autogeny-influencing chromosomes per

individual assessed on the basis of each of five hypotheses that assumed that one, two, or all of the three pairs of chromosomes characteristic of *C. pipiens*, including and excluding the sex chromosomes in the case of the first two, are involved. The proportion of females in which ovarian diapause was terminated increased directly with the gene dosage (the mean number of autogeny-inducing chromosomes per individual). No dominance was apparent, but partial sex-linkage occurred. Statistical analysis of the data indicated that, when cross-over is discounted, the hypothesis limiting the autogenous factor to the sex chromosome was invalid and that control by the three pairs of chromosomes was the most likely. Yellow colour of the fat in the larvae and pupae of the autogenous colony afforded a genetic mark regulated by a recessive factor linked neither with sex nor with autogeny. In the light of this finding, it is suggested that autogeny is inherited on only two pairs of chromosomes, one carrying the sex factor, and that cross-over may occur between the factors controlling sex and autogeny.

It was concluded that a criterion of autogeny that allowed comparison of autogeny rates between populations was provided by either egg maturation or termination of ovarian diapause; the first was almost as effective a criterion as the second when the gene dosage was high, but was poor when it was low. A low rate of autogeny in the F_1 hybrid of the autogenous male was accompanied by low fecundity, and is attributed to a general effect on vitality that limits reproductivity.

Autogeny is presumably a condition lacking ovarian diapause, which is considered to be genetically controlled, possibly through the mediation of the hormone of the corpus allatum; the greater the gene dosage, the greater is the probability that the diapause will be spontaneously terminated. There was no relation between the number of eggs matured per female and the autogenous genetic potential, and it is suggested that the regulation of egg numbers by resorption of follicles after initiation of ovarian development is independent of the genetic control of ovarian diapause and may be regulated, in anautogenous females, by different properties of of the blood-meal.

RAMACHANDRA RAO (T.) & RAJAGOPALAN (P.K.). **Observations on Mosquitoes of Poona District, India, with special Reference to their Distribution, seasonal Prevalence and the Biology of Adults.** — *Indian J. Malar.* **11** no. 1 pp. 1—54, 9 figs., 12 refs. Kanpur, 1957.

Investigations on virus diseases in the Poona District of Bombay State included studies, made between April 1953 and March 1955, of the mosquitos present, the daytime resting places and seasonal prevalence of the adults, and their biting habits with particular reference to man. Routine collections at fixed stations for fixed periods, and general collections in other places for varying periods, both indoors and outdoors, were made in four field study areas in the three topographical and climatological regions representative of the District; one of the areas lay in the western hilly region with high rainfall, two in the intermediate undulating region with moderate rainfall (one in urban and the other in rural conditions) and the fourth in the dry eastern plateau. Nearly 90 species belonging to 11 genera were taken, including about a dozen for which specific determinations could not be made. Over 5,300 mosquitos of some 40 species were caught alighting on man, and females of nearly all these species were found to take human blood. The species taken on man in fair numbers were *Culex bitaeniorhynchus* Giles, *C. pipiens fatigans* Wied., *C. vishnui* Theo.,

Armigeres obturbans (Wlk.), *Mansonia crassipes* (Wulp), *Anopheles hyrcanus* Wied., *A. moghulensis* Chr., three species of *Aëdes* of the subgenus *Stegomyia* (*A. albopictus* (Skuse), *A. w-alba* (Theo.) and *A. vittatus* (Big.)) and seven species of *Aëdes* of other subgenera including *A.* (*Aëdimorphus*) *vexans* (Mg.). The three species of *Stegomyia* accounted for 4,693 of the total.

Data are given on the distribution, seasonal prevalence and habits of each of the species collected, and attention is drawn to the possible importance of some in the transmission of virus diseases. *C. p. fatigans* was the most abundant mosquito in all the study areas, except that in the western hills, and was the only species found in houses in Poona City, where routine house spraying with DDT had little effect on its density. Large numbers were collected in outdoor shelters, on bushes and in sugar-cane fields and gardens. It showed no consistent seasonal trends. Small numbers were taken biting man at dusk in all areas, and a few females alighted on man during the day. Some also came to traps baited with birds or rats. The natural occurrence and experimental transmission of West Nile virus in Israel have been reported in another member of the same complex, *C. p. molestus* Forsk. [*R.A.E.*, B **45** 162–163]. *C. vishnui* was taken in all the study areas, resting both outdoors and indoors. It also came once each to pigeon- and fowl-baited traps and occasionally attempted to bite man at dusk. It was the second most abundant species of *Culex* and was taken in all months of the year, with maximum abundance from July to January, the first four months of which were the monsoon season. *C. bitaeniorhynchus* was also common and generally rested outdoors, being found regularly in sugar-cane fields and in gardens; it was occasionally found in houses. It bit man both at dusk and during the day but not in large numbers, and was taken in bird- and rat-baited traps. It was found in all months but with increased prevalence at the monsoon season. *C. univittatus* Theo., a vector of West Nile virus in Egypt [**43** 49–50; **46** 158–159], was collected in small numbers in all months of the year, generally from bushes and vegetation, and one female was taken biting man in January. The species has hitherto been recorded from very few places in India and Pakistan. *A. vexans*, from which the virus of western equine encephalitis has been recovered in the United States [**43** 176], was taken biting at dusk and also during the day and resting on bushes and sugar-cane. It was most prevalent in the irrigated areas and was not found in the heavy-rainfall area. It occurred in greatest numbers during and immediately after the monsoon. *A. aegypti* (L.), which was formerly common in Poona, was represented in the catches by one male only. Its disappearance may be due to the widespread use of DDT for house spraying. *A. albopictus* was probably the most abundant species in the gardens in Poona City and in forest regions. It was found in all areas and all months, particularly during and immediately after the monsoon. *A. vittatus* and *A. w-alba* were also widespread and common. All three bit man avidly both during the day and at dusk. The hitherto unknown larva and pupa of *A. w-alba* were found for the first time.

In the course of examination, at Poona, over 2,000 pools comprising over 120,000 mosquitos of more than 40 species from western and southern India, a virus belonging to the West Nile and Japanese B complex [*cf.* **31** 203] was isolated in southern India from *C. vishnui*, an unidentified virus was recovered from *C. bitaeniorhynchus* from a village at the foot of the Western Ghats, near one of the Poona collecting stations, Sindbis virus [**45** 101] was recovered from a pool of *C. vishnui* collected in Kolaba District and from a mixed pool of *Culex* spp. from North Kanara District, both in Bombay State, and at least three other strains of unidentified

viruses were isolated from pools of *C. vishnui* in North Arcot District, Madras State. K. C. Smithburn, J. A. Kerri & P. B. Gatne have recently found that the blood of the indigenous inhabitants in several parts of western and southern India contains neutralising antibodies for several known neurotropic viruses, particularly West Nile virus, and T. H. Work & K. V. Shah reported an outbreak of disease of the type of Japanese B encephalitis in southern India. Mosquitos of various species, and particularly *C. vishnui*, may therefore play an important part in the transmission of neurotropic viruses in India.

BHATIA (M.L.), WATTAL (B.L.) & MAMMEN (M.L.). **Preferential indoor Resting Habits of *A. culicifacies* Giles near Delhi.** — *Indian J. Malar.* **11** no. 1 pp. 61—71, 3 figs., 13 refs. Kanpur, 1957.

The daytime resting habits of *Anopheles culicifacies* Giles were studied in human dwellings and cattle sheds in Kinauni, an unsprayed village near Delhi, from August 1954 to September 1956. Collections were made between 7 and 11 a.m. The mosquitoes were present in every month of the survey period. More than 60 per cent. of those taken were resting on the ceiling or on cobwebs hanging from it, 76.9 per cent. were on such resting places, or shelves or walls 6 ft. or more above floor level and 84.3 per cent. were 4 ft. or more above floor level. There was some indication that the wall with the door was preferred to any of the other three, but the difference was slight. Hanging objects, shelves and objects on the floor served only incidentally as resting places. Corners and other dark places were avoided. The chief factor responsible for the high density of *A. culicifacies* on the ceiling and the cobwebs hanging from it is probably the marked negative geotropism of the species, but dim light, a resting surface of a somewhat coarse texture, minimum air movement and moderate relative humidity may also play a part. The findings on resting heights contrast with those of Rafi in Pakistan [*R. A.E.*, B **45** 150], and it is suggested that, in parts of northern India in which *A. culicifacies* is the only vector of malaria, a spray programme ensuring complete coverage of the ceiling and of the walls above a level of 3 ft. from the floor should stop transmission.

DHIR (S.L.) & RAHIM (A.). **Malaria and its Control in Afghanistan (1950—1954).** — *Indian J. Malar.* **11** no. 1 pp. 73—126, 10 figs., 4 refs. Kanpur, 1957.

Malaria is endemic almost throughout Afghanistan but is commonest in the river valleys, where irrigation is practised for the cultivation of rice, and negligible elsewhere. During the surveys begun in 1949 to provide preparatory data for large-scale control measures, parasite rates of 1.7—30.1 per cent. were found in children aged 2—9 years. *Plasmodium vivax* was the commonest parasite early in the transmission season (July—October), and *P. falciparum* towards the end, except in Kabul, where *P. vivax* predominated throughout the season [*cf. R.A.E.*, B **43** 110]. Anopheline activity was practically confined to the period from June to late October. During the investigations, 15 species of *Anopheles* were recorded. The chief vector is *A. superpictus* Grassi, with *A. culicifacies* Giles as a secondary vector in the Mashraqi (Eastern) Province. *A. superpictus* was the most plentiful single species in August and September in all areas; it breeds mainly in sunlit pools in stony river beds and in rice-fields [*cf.* **46** 149].

A. culicifacies breeds in rice-fields, rocky rivers and streams, irrigation channels and swamps. Sporozoite rates of 0.034–0.4 were recorded in *A. superpictus* in 1949–54, and one of 0.44 was recorded in *A. culicifacies* in 1949. Both species rest indoors in dwellings and cattle sheds and are equally vulnerable to DDT. The malaria season lasts about three months, and the actual peak transmission period only about eight weeks. Transmission was stopped by only one round of spraying with wettable DDT at 1 g. per sq. metre in dwellings and animal quarters, and this remained effective for 12–14 weeks. Spraying at twice the rate gave no advantage. Large-scale surveys of treated areas, undertaken at the end of 1953 to assess the results of four years' control operations, showed that a spectacular reduction in spleen indices and infant parasite rates had been effected, together with a significant decrease in the incidence of malaria and the use of antimalarial drugs. A consequent improvement in the agricultural and industrial economy was noticed. The prospects of eliminating the disease from Afghanistan by long-term operations are considered hopeful.

An Outbreak of St. Louis Encephalitis in the Lower Rio Grande Valley of Texas in 1954. — *Publ. Hlth Rep.* 72 no. 6 pp. 510–535, 7 graphs, 1 map, 24 refs. Washington, D.C., 1957.

One of the largest outbreaks of St. Louis encephalitis ever recorded occurred late in the summer of 1954 in the Lower Rio Grande Valley of Texas, where the disease had not previously been known. A comprehensive study of the outbreak was made, and the results are described in four papers. One of these is **Clinical and pathological Features**, by C.M. KUNIN & T.D.Y. CHIN (pp. 519–525, 5 graphs, 4 refs.); the others are noticed below.

CHIN (T.D.Y.), HEIMLICH (C.R.), WHITE (R.F.), MASON (D.M.) & FURCOLOW (M.E.). **Epidemiological Features**, pp. 512–518, 2 graphs, 9 refs. Investigations showed that 373 cases of encephalitis, with ten deaths, had been recorded in the area, mostly between mid-August and mid-September, but more than 1,000 had probably occurred. The incidence was highest in persons over 50 years of age and among urban dwellers. The seasonal incidence and age distribution resembled those of the 1933 outbreak in St. Louis [*cf. R.A.E.*, B **24** 253], and the St. Louis virus was subsequently isolated from the brain tissue of one fatal case and from two pools of *Culex pipiens fatigans* Wied. (*quinquefasciatus*, auct.). A fourfold or greater increase in complement-fixing antibodies for St. Louis virus was demonstrated in 43.7 per cent. of the patients tested, and complement-fixing antibodies were also found in 70 per cent. of people examined who had presumably been exposed to infection but had not developed symptoms. There was no evidence of concurrent epizootics.

SULLIVAN (T.D.), IRONS (J.V.) & SIGEL (M.M.). **Laboratory Aspects**, pp. 526–530, 8 refs. In this paper, accounts are given of the virological and serological work in which the results mentioned above were obtained.

BEADLE (L.D.), MENZIES (G.C.), HAYES jr. (G.R.), VON ZUBEN jr. (F.J.) & EADS (R.B.). **Vector Evaluation and Control**, pp. 531–535, 5 refs. The climate and topography of the area are very propitious for mosquito production, and heavy rainfall in April had produced flooding with such favourable conditions for breeding that a reconnaissance survey indicated the need for emergency control measures (application of larvicides and space sprays, house spraying and some drainage), which reduced adult mosquito populations to negligible proportions by 7th May. The outbreak

of encephalitis prompted an entomological investigation, which was begun in late August. Larval collections then and in early September showed that the predominant mosquitos were *C. p. fatigans*, breeding in artificial containers and semi-permanent ground pools and ditches, particularly near sewage disposal plants, and *Psorophora confinnis* (Lynch Arrib.), breeding in temporary rain pools. Catches made with three light-traps between 6th and 12th September yielded only 530 mosquitos, including 325 of *P. confinnis* and 73 of *C. p. fatigans*, and collections in shelters between 6th and 14th September and at human bait in the evening between 6th and 10th yielded 1,083 and 407 mosquitos, of which 1,022 and 312, respectively, were *C. p. fatigans*. In all, 1,613 mosquitos, representing the 11 species collected, were tested for virus in 29 pools, and two strains of the virus of St. Louis encephalitis were isolated from *C. p. fatigans* collected at Edinburg. These facts strongly suggest that *C. p. fatigans*, which has not previously been considered of importance in the transmission of St. Louis encephalitis [*cf.* **43** 133], was the principal vector. *C. tarsalis* Coq., believed to be the chief vector of St. Louis encephalitis in California [**41** 127, etc.], was not found. Mosquito control operations carried on within the area from 9th to 23rd September were directed at all species. They consisted of anti-adult treatment in urban areas with 5 per cent. DDT emulsion spray or 3 per cent. γ BHC dust and larvicidal treatment in all urban and some rural areas with 5 per cent. DDT in oil or emulsion sprays. A population of about 72,000 was protected, and mosquito populations were reduced to satisfactory levels.

MCGUIRE (C.D.) & DURANT (R.C.). **The Role of Flies in the Transmission of Eye Disease in Egypt.** — *Amer. J. trop. Med. Hyg.* **6** no. 3 pp. 569–575, 8 refs. Baltimore, Md., 1957.

The following is largely based on the authors' summary. A study was made of the types of bacterial flora associated internally and externally with adults of *Musca domestica vicina* Macq. and *M. sorbens* Wied. collected from the faces of children in villages in the Nile Delta from August 1955 to June 1956. Collections were made weekly, and for each species 160 pools, of ten flies each, were examined. Enteric bacteria were found in every pool of flies, and organisms associated with respiratory infections, conjunctivitis and pyogenic infections were frequently isolated. No significant difference was found in the bacterial flora of the two species of flies. Although the total bacterial count showed no seasonal variation, the percentage of pools positive for organisms of the *Micrococcus* group, which were isolated more often than any others, rose sharply in March and remained high during March–June and August–September (no observations being made in July), but fell sharply in October. Organisms of this group were isolated about half as many times again from the internal structures as from the surface of the flies. Within it, the β-haemolytic staphylococci and streptococci were isolated most frequently during August and the non-haemolytic and α-haemolytic micrococci during April, May, June and August. *Corynebacterium* was isolated most frequently in May and June. Bacteria of types similar to those isolated from flies were obtained from both normal and diseased eyes of Egyptian children. The organisms most commonly isolated from both eyes and flies were the haemolytic micrococci. Several of these, isolated from one source or the other, produced a mild conjunctivitis in experimentally infected rabbits, similar to that frequently seen in Egyptian children. The presence of *Neisseria gonorrhoeae* and *Haemophilus influenzae* was occasionally demonstrated in infected eyes and flies.

SMITH (W.W.). **Populations of the most abundant Ectoparasites as related to Prevalence of Typhus Antibodies of Farm Rats in an endemic Murine Typhus Region.** — *Amer. J. trop. Med. Hyg.* 6 no. 3 pp. 581—589, 7 figs., 20 refs. Baltimore, Md., 1957.

Murine typhus is endemic in the southern United States, and since 1943 most human cases have occurred in rural areas [*cf. R.A.E.*, B **39** 108]. Rats on scattered farms are believed to be the most important vertebrate reservoirs. Rats and their ectoparasites are more difficult to control in rural than in urban areas because measures are more difficult to apply and there is much greater seasonal fluctuation in ectoparasite populations. In 1946—51, a study was made of the ectoparasites of 270 individuals of *Rattus norvegicus* and 378 of *R. rattus*, taken alive from untreated farm premises in parts of Alabama, Arkansas, Georgia and Texas that had an average noon relative humidity in July of 50—60 per cent. and showed high endemicity of murine typhus in man; its purpose was to determine the relative importance of the chief ectoparasites of rats living in such situations. The survey period was one of high ectoparasite populations and typhus incidence. The monthly incidence of typhus antibodies in both species of *Rattus* was strongly correlated with the monthly abundance of *Xenopsylla cheopis* (Roths.) but showed no relation to that of *Ornithonyssus* (*Bdellonyssus*) *bacoti* (Hirst) or *Polyplax spinulosa* (Burm.). It is concluded that *X. cheopis* is the most important ectoparasite concerned in the transmission and maintenance of murine typhus in the rats of the farm buildings of the area studied, that *O. bacoti* is of doubtful importance and *P. spinulosa* unimportant.

MYKYTOWYCZ (R.). **The Transmission of Myxomatosis by *Simulium melatum* Wharton (Diptera: Simuliidae).** — *C.S.I.R.O. Wildl. Res.* 2 no. 1 pp. 1—4, 8 refs. Melbourne, 1957.

Rabbits with advanced myxomatosis sometimes have secondary lesions on the ears in the form of small pisiform swellings, but infected rabbits in an area of fringing forest on the Murray River in north-central Victoria were found in January 1951 to have large swellings, of a kind not previously seen, that caused the ear to hang down. This suggested that the animals were being bitten on the ears by an insect that transmitted the disease, and investigation led to the discovery of blood-engorged adults of *Simulium melatum* Wharton on the ear of a sick rabbit [*cf. R.A.E.*, B **42** 77]. This species breeds for preference in small slow-flowing streams, and no adults were found near the Murray River and no immature stages in the river itself.

An experiment was made at a site about half a mile from the river, where *S. melatum* had been particularly active for two weeks, feeding on lethargic infected rabbits. Three healthy domestic rabbits were exposed on six consecutive days from 7 a.m. to 6 p.m. in cages about 50 yards apart, raised 2 ft. from the ground to prevent contact with wild rabbits. The cages were cover at 6 p.m. to prevent mosquito attack and transferred to a shed. The rabbits were kept under continuous observation during the exposure period, and the sites of Simuliid bites were recorded. No blood-sucking flying insects except *S. melatum* were seen to come in contact with the rabbits, which did not try to dislodge the Simuliids. Every bite gave rise to a small swelling, capped with coagulated blood, which disappeared after 3—4 days, leaving the ear with red inflamed areas round the punctures visible for up to nine days against the light. Two of the rabbits

developed myxomatosis and showed the extensive ear swellings noted in the field, as well as the usual symptoms. Two control rabbits, kept in insect-proof cages, remained healthy, and both developed the disease in a normal form when challenged with virus three weeks later. It is concluded that *S. melatum* played a part in spreading the disease in the local epizootic.

Simuliids have strong but short mouth-parts and have to rasp a hole in the skin to reach the blood vessels. Their bite is believed to be painless when inflicted and the saliva to be anaesthetic and to increase the flow of blood. As even minor skin lesions are predisposed to the development of myxomatosis tumours when the disease becomes generalised, it is likely that an infective Simuliid bite, which causes substantial damage to the skin tissue, would give rise to a larger swelling than would a mosquito bite. Moreover, Simuliids tend to attack the host in large numbers, and extensive oedema develops when the swellings round a group of adjacent punctures coalesce. Because of their short mouth-parts, Simuliids concentrate on accessible skin with little or no fur covering, such as the ears. The observations reported support the supposition that in certain parts of Australia Simuliids have been responsible for localised outbreaks of myxomatosis [*cf.* **45** 207].

MYERS (K.). **Observations on the Sampling of Mosquito Larvae and Pupae in the Field.** — *C.S.I.R.O. Wildl. Res.* 2 no. 2 pp. 111—115, 1 ref. Melbourne, 1957.

In southern New South Wales, the aquatic stages of *Aëdes alboannulatus* (Macq.) were sampled daily for four weeks in October 1952 in three roadside pools in which they occurred in almost pure culture. Two of the pools were 4 in. deep when full; one of them was very small and free of vegetation, and the other, somewhat larger, had marginal vegetation of *Juncus* sp. on one side. The third pool was much larger and over 12 in. deep when full; it was surrounded by a dense margin of *Juncus* sp. and *Carex* sp. The water level fluctuated in all three. The eggs of *A. alboannulatus* were laid on the mud at the edge of the water, and hatching began within two days of each rise in the level of the pools after rain. Large numbers of larvae were found in the two smaller pools, both of which provided good oviposition sites, and the medium-sized one, which apparently had a short enough life to hinder the development of large populations of predators, produced adults steadily. The smallest, which sampling would have indicated as an important breeding place for most of the month, produced no mosquitos at all, as it dried up too often, nor did the largest, probably because the thick vegetation on its margin made it unsuitable for oviposition and its long life allowed a dense population of predators to build up. Sampling for species such as these, which require water of fluctuating levels for successful breeding, poses more difficulties than sampling for such mosquitos as *Culex annulirostris* Skuse and *Anopheles annulipes* Wlk., which oviposit directly on the surface of the water and breed steadily over long periods in relatively stable habitats such as swamps [*cf. R.A.E.*, B **43** 133].

MYKYTOWYCZ (R.). **Ectoparasites of the Wild Rabbit,** *Oryctolagus cuniculus* **(L.), in Australia.** — *C.S.I.R.O. Wildl. Res.* 2 no. 1 pp. 63–65, 9 refs. Melbourne, 1957. **Parasitic Habit of the Rabbit Mite,** *Cheyletiella parasitivorax* **(Megnin).** — *T. c.* no. 2 p. 164, 2 refs. **Contact Transmission of infectious Myxomatosis of the Rabbit,** *Oryctolagus cuniculus* **(L.).** — *Op. cit.* 3 no. 1 pp. 1–6, 1 fig., 9 refs. 1958.

In the first paper, a list is given of ectoparasites found on wild rabbits in Australia during field surveys of myxomatosis, together with those recorded by Seddon in a paper already noticed [*R.A.E.*, B **37** 144]. The list shows the States from which the various species have been recorded, their other known hosts in Australia and their relation to rabbits. The species listed include ectoparasites of native and domestic animals that have adopted the rabbit as an alternative host in sporadically distributed areas apparently depending on environment, species for which the rabbit is only an occasional host on which they are rarely found, and three of which the rabbit is the natural host. The last three, which comprised two mites, *Cheyletiella parasitivorax* (Mégn.) and *Listrophorus gibbus* Pgst., and a louse, *Haemodipsus ventricosus* (Denny), were widely distributed irrespective of the environment and infested a high proportion of individuals.

Until recently, some authors maintained that *C. parasitivorax* did not attack the rabbit but preyed on other soft-bodied mites on the same host [**38** 190]. Others have affirmed that it feeds on the host and can induce pathological changes in it [**43** 180], and the author records in the second paper that he repeatedly observed under the dissecting microscope that, on transfer from a dead to a living rabbit, *C. parasitivorax* attached itself to the skin and became engorged with colourless fluid. Once attached, it was difficult to remove. When *C. parasitivorax* and *L. gibbus* were kept together in vials at room temperature, the former was not observed to prey on the latter and usually died 2–3 days before it. On the living rabbit, *L. gibbus* generally infests the hair in the neck and the ventral surface of the tail, whereas *C. parasitivorax* is found on the skin, usually on the abdomen and back. Moreover, *C. parasitivorax* has repeatedly been found on young animals free of other soft-bodied mites. Though these observations leave little doubt that *C. parasitivorax* feeds directly on the host, no gross dermal lesions attributable to it were seen on hundreds of rabbits examined.

Various ways in which myxomatosis can be transmitted by direct contact are discussed in the third paper, and an account is given of tests in which the ability of *C. parasitivorax* and *H. ventricosus* to transmit it is demonstrated. Two out of four suspensions of *H. ventricosus* from infected rabbits gave positive results when injected into susceptible ones, but 253 living lice transferred from sick to healthy rabbits in seven groups failed to effect transmission. However, when 124 lice, collected from healthy rabbits, were starved for 3–4 days and forcibly fed on myxomatosis tumours, transmission was effected by one of the five groups into which they were divided. When suspensions of ten and 28 individuals of *C. parasitivorax*, taken from living infected rabbits, were inoculated into two healthy rabbits, both developed fatal myxomatosis. Two suspensions prepared from mites that had abandoned the dead body of an infected rabbit were both positive. Two of eight batches of mites, each comprising 15–120 individuals, transmitted myxomatosis when immediately transferred to the fur of healthy rabbits from others that were in an advanced stage of the disease or had recently died of it. It is doubtful whether *H. ventricosus* or *C. parasitivorax* could originate and maintain a myxomatosis epizootic, but they may help to maintain infection between epizootics. The sporadic distribution of

some ectoparasites of the wild rabbit in Australia and the occurrence of localised winter outbreaks of myxomatosis in the absence of mosquito activity suggest that there may be more effective ectoparasite vectors than the two tested, such as, for example, *Ornithonyssus* (*Bdellonyssus*) *bacoti* (Hirst) and *Euschöngastia* (*Schöngastia*) *antipodianum* (Hirst), which were repeatedly collected during winter in scattered localities. Since the former feeds on the ears and the latter on the eyelids, contamination of their mouth-parts would be ensured.

BURNETT (H.S.), PARMELEE (W.E.), LEE (R.D.) & WAGNER (E.D.). **Observations on the Life Cycle of** *Thelazia californiensis* **Price, 1930.** —*J. Parasit.* **43** no. 4 p. 433. Lancaster, Pa., 1957.

Thelazia californiensis has been found in the eyes of mammals in California and in some adjacent areas of Oregon and Nevada. Its known definitive hosts include man, dog, deer, cat, horse and sheep. In preliminary studies on the intermediate host, in which various laboratory-reared flies were fed on sheathed embryos of the nematode and examined at intervals after being crushed under a cover slip, developmental forms of *T. californiensis* were found in *Fannia canicularis* (L.). Similar developmental forms of a nematode were found in adults of *F. flavipalpis* Stein (*benjamini* Mall.) collected in southern California, an area endemic for the eye worm, and it is believed that they are the results of natural infections with *T. californiensis*. This is the first record of the intermediate host of any species of *Thelazia* in the United States.

RAHMAN (M.H.). **Observations on the Mode of Infection of the Hump of Cattle by** *Stephanofilaria assamensis* **in East Pakistan.** —*J. Parasit.* **43** no. 4 pp. 434–435, 2 refs. Lancaster, Pa., 1957.

A description is given of *Stephanofilaria assamensis*, which is associated with hump sore of cattle in East Pakistan. The condition occurs chiefly in cattle more than seven years old, and more in male animals than in females, in imported Sindhi and Mariana cattle than in the local breed and outside villages than in them. Strong, healthy cattle are as susceptible as weak ones. Seasonal variation in incidence is not great, but cases are most numerous during the monsoon rains, when flies are abundant and cattle are kept indoors because of floods. In a transmission experiment in which cattle with hump sore and others without were kept together in a fly-proof shed for three weeks with about 1,000 flies, the healthy cattle did not develop hump sore, but transmission was effected when the skin of the hump was artificially broken by scraping. No filarial larvae were found in 100 flies that were dissected, but seven had such larvae on the surface of the body. When the flies were put in water, the larvae could be seen moving on them and agitation caused them to become detached and move freely in the water. It is concluded that transmission is mechanical and that a previous break in the skin is necessary. Cattle often make wounds by rubbing the side of the hump against a rough surface, and flies feeding at the wounds deposit larvae of *S. assamensis* in them from infected cattle. These larvae cause irritation and more rubbing, and when they have matured, the females produce more larvae, and a fully developed hump sore is established within a few months.

ARTHUR (D.R.). **Re-description of *Ixodes lunatus* Neumann 1907 and of a new Species confused therewith, from Madagascar.** — *J. Parasit.* **43** no. 4 pp. 474–483, 37 figs., 4 refs. Lancaster, Pa., 1957.

The author redescribes the female of *Ixodes lunatus* Neum. from new material collected in Madagascar, describes *I. colas-belcouri*, sp. n., from adult males and females, nymphs and larvae from *Rattus rattus* and insectivores, also in Madagascar, and gives characters distinguishing the two species. The material identified as *I. lunatus* by Colas-Belcour & Grenier [*R.A.E.*, B **31** 96] in all probability belonged to *I. colas-belcouri*.

GHOSH (S.M.) & BANDYOPADHYAY (A.K.). **Preliminary Observations on the Role of dried Human Blood as an Adjunct to the larval Food in artificial Breeding of *Anopheles stephensi*.** — *Bull. Calcutta Sch. trop. Med.* **6** no. 1 pp. 16–17. Calcutta, 1958.

A comparison through seven generations was made of the growth and activity of *Anopheles stephensi* List. reared in water containing yeast powder alone or with the addition of powdered dried clots of human blood or dried human serum. Yeast powder was given in adequate quantities daily and the blood or serum added every two days. In the 2nd to 7th generations the average durations of the larval stage on yeast alone, on yeast and serum and on yeast and blood were 7–8, 7 and 5–6 days, respectively. Females developing from larvae reared on yeast alone or yeast and serum laid 75–80 eggs each, whereas those developing from larvae reared on yeast and blood laid 110–130 eggs and were more active and alert.

PAPERS NOTICED BY TITLE ONLY.

PRINGLE (G.) & GARRETT-JONES (C.). **Additions to the *Anopheles* Fauna of Iraq: *A. sergenti* Theobald and *A. apoci* Marsh.** — *Bull. endemic Dis.* **2** no. 1–2 pp. 88–91, 1 ref. Baghdad, 1957.

WEBBER (L.G.). **Utilization and Digestion of Carbohydrates by the Australian Sheep Blowfly *Lucilia cuprina*.** — *Aust. J. Zool.* **5** no. 2 pp. 164–172, 29 refs. Melbourne, 1957.

HICKS (E.A.). **Check-list and Bibliography on the Occurrence of Insects in Birds' Nests.** — 9¼ x 6¼ in., 681 pp., many refs. Ames, Iowa, Iowa St. Coll. Pr. [1959]. Price $8.50.

ROBERTSON (J.G.). **Paper Chromatography in Insect Taxonomy.** — *Canad. J. Zool.* **35** no. 3 pp. 411–419, 2 figs., 12 refs. Ottawa, 1957. [See *R.A.E.*, A **47** 265.]

FLOCH (H.) & FAURAN (P.). **Ixodides de la Guyane et des Antilles Françaises.** — *Arch. Inst. Pasteur Guyane* **19** no. 446, 94 pp., 13 figs., 105 refs. [Cayenne] 1958.

Mouchet (J.), Gariou (J.) & Rivola (E.). **Observations sur la biologie d'*Anopheles smithi* var. *rageaui* Mattingly et Adam 1954, vecteur d'un *Plasmodium* de mammifère aux environs de Yaoundé (Sud-Cameroun).**—*Bull. Soc. Path. exot.* **50** no. 1 pp. 157–164, 2 pls., 1 map, 5 refs. Paris, 1957.

During observations on *Anopheles smithii* var. *rageaui* Mattingly & Adam in various localities in the forest to the west and north of Yaoundé in the French Cameroons [*cf. R.A.E.*, B **47** 3], larvae were found most often in very shallow pools in dark rocky streams, and the adults among the rocks. It is now thought that this is only incidentally a cave-dwelling mosquito [*cf.* **43** 80]. The blood-meals of 67 females, examined by the precipitin test, using antisera including that of man, gave no positive reactions except to that of the forest porcupine (*Atherurus africanus*), on which 25 of the females were shown to have fed. Men exposed in a hut, or in the open near resting places where adults were plentiful, were not attacked. The glands of more than 20 per cent. of the females dissected were infected with a *Plasmodium*, which small-scale preliminary experiments indicated was probably a parasite of the porcupine. It is concluded that *A. s. rageaui* is not likely to play any part in the transmission of human malaria.

Déduit (Y.) & Callot (J.). **Études sur la ponte par autogénèse des culicides. I. Données numériques sur l'acte de ponte chez la femelle vierge isolée de *Culex pipiens autogenicus* Roubaud.**—*C. R. Soc. Biol.* **149** no. 9–10 pp. 1003–1006, 2 graphs. Paris, 1955.

Déduit (Y.). **II. Données numériques sur l'acte de ponte chez la femelle fécondée de *Culex pipiens autogenicus* Roubaud.**—*Op. cit.* **151** no. 5 pp. 974–977, 3 graphs, 1 ref. 1957.

As the females of *Culex pipiens molestus* Forsk. (*autogenicus* Roub.) can oviposit autogenously only if the larvae have sufficient food [*R.A.E.*, B **19** 215; **40** 67], the possibility of using a size character to show whether a female will develop eggs autogenously was investigated. The character adopted was the length of the wing. The original observations, made on isolated virgin females and described in the first part of the paper, showed that as wing length increased, so did the percentage of autogenous females and the number of eggs per raft, but the number of rafts laid was unaffected.

The experiments recorded in the second part were designed to show whether the above results had been influenced by the use of unmated females. Although the proportions of females that developed eggs and the numbers of eggs formed were the same in females each confined with a male as in the isolated ones, more of the former oviposited and more laid all their eggs.

Riches (J. H.) & O'Sullivan (P. J.). **The Value of the organic Phosphorus Insecticides Malathion and Diazinon for the Protection of Sheep against Body Strike.**—*Aust. vet. J.* **33** no. 2 pp. 34–38, 4 refs. Sydney, 1957.

The following is based on the authors' summary. Malathion and diazinon [O,O-diethyl O-2-isopropyl-4-methyl-6-pyrimidinyl phosphorothioate] were compared with aldrin, dieldrin and BHC for effectiveness in protecting sheep against body strike by blowflies (*Lucilia cuprina* (Wied.)) in Queensland. The insecticides were applied in emulsions by jetting [*cf. R.A.E.*, B **46** 55] to a strip about 12 in. wide from just in front of the withers to the butt of the tail, the area on which most body strikes originate. Care was taken to saturate the wool to the skin. A treatment was considered to have lost its effectiveness, which was tested weekly by putting 200–300 freshly hatched

blowfly larvae on the skin of the treated part of the experimental animals kept under field conditions, when the larvae survived for 24 hours on two separate occasions on 50 per cent. of the sheep. Malathion at 0·05, 0·1 and 0·25 per cent. was effective for 7, 8–9 and 10 weeks, respectively. Aldrin and dieldrin at the same concentrations were effective for 11–18 weeks and γ BHC for 8–14 weeks. In one experiment, diazinon at 0·008 per cent. was effective for 23 weeks and at 0·04 per cent. for 33 weeks, whereas aldrin at 0·05 per cent. lost its effectiveness after nine weeks. In a second experiment, carried out during a period of high summer rainfall (35·56 in. in 18 weeks), diazinon at 0·02 per cent. gave protection for only 16–18 weeks and dieldrin at 0·025 per cent. for 7–9 weeks. In this experiment, no difference in the effectiveness of either insecticide could be detected on sheep with wool $\frac{3}{4}$–1 in., $1\frac{3}{4}$–2 in. or $2\frac{1}{2}$–3 in. long [*cf.* **44** 89–90]. The results showed that a concentration of not less than 0·02 per cent. diazinon would probably be necessary under field conditions to prevent body strike for long periods during which high rainfall occurs.

Grewal (M. S.). **Pathogenicity of *Trypanosoma rangeli* Tejera, 1920 in the Invertebrate Host.**—*Exp. Parasit.* **6** no. 2 pp. 123–130, 1 fig., 20 refs. New York, N. Y., 1957.

First-instar nymphs of *Rhodnius prolixus* Stål that fed on laboratory animals infected with *Trypanosoma rangeli* [*cf. R.A.E.*, B **42** 178, etc.] suffered considerable mortality during that and subsequent instars; many could not moult, and these all had heavy infections, generally involving the haemolymph. Infected bugs were sluggish, unnaturally light in colour and translucent. In one experiment, only 41 of 120 infected first-instar nymphs reached the adult stage and these survived a long time; only one of them was infected in the haemolymph. Mortality was higher when the nymphs were fed on animals with heavier infections. The effects of the trypanosome were even more severe on *Cimex lectularius* L., in which invasion of the haemolymph was rapid, and infected individuals that reached the adult stage did not survive for more than three meals after doing so. Mortality was higher in bugs with heavier infections in the haemolymph. It was probably not connected with the penetration of the gut wall, as it occurred in *R. prolixus* infected by direct introduction of trypanosomes into the haemolymph. Preliminary studies indicated that a deficiency in the concentration of certain amino acids interfered with the moulting process in infected bugs.

Hollins (F. R.). **The Atoll of Ontong Java, its Depopulation and Malaria Control.**—*J. trop. Med. Hyg.* **60** no. 10 pp. 231–237, 2 maps, 10 refs. London, 1957.

The population of the islands composing the atoll of Ontong Java in the British Solomon Islands Protectorate fell from about 5,500 in 1907 to 1,016 in 1921 and 768 in 1954. This was attributed to the introduction of respiratory diseases and malaria, though the causal relationship could not be proved. Spleen rates of 75 and 56 per cent. were found in 1951 on Leuaniua and Avaha, the two main islands, and the vector was identified as *Anopheles farauti* Lav. [*cf. R.A.E.*, B **44** 191]. Earlier attempts to prevent the fresh introduction of respiratory diseases had failed to reverse the population trend, and a large-scale anti-malaria campaign was therefore projected. In an initial survey, *A. farauti* was found to be breeding extensively in swamps in which giant taro (*Alocasia indica*) was growing near the main village on Leuaniua and was also breeding on Hungaaka, an island occupied by a Melanesian boys' school; it was not found on the swampy island of Pelau,

but because malaria was believed to be endemic there it was decided to treat all potential breeding places on that island also. As breeding places on the atoll were limited in number, it was felt that eradication of the vector should be possible, and the remoteness of the islands would prevent its easy reintroduction.

A programme to control *A. farauti* by the combined efforts of the medical authorities, the Administration and the local population was undertaken in July 1954, in the hope of developing a technique that could be applied on other small islands throughout the Protectorate. The local people were organised into a labour force, a food-producing party and a force to maintain the gardens. The swamps on Leuaniua, Pelau and one other small island were cleared and sprayed with 5 per cent. DDT in oil, and pits were made and stocked with *Gambusia*, which was already well established in some parts. Coconut shells and husks, in which Culicines bred extensively, were gathered and burnt, and houses were sprayed with 5 per cent. DDT in kerosene on Leuaniua. The only breeding place found on Hungaaka was small and was filled in, and the only suitable breeding place for *A. farauti* on Avaha had dried up. Most of the remaining islands had no standing water. In a survey six months after the campaign, no Anophelines were found except on Leuaniua, where one adult and two larvae were taken. The digging of more pits for *Gambusia* was advised. After a further six months, two Anopheline larvae were found near the village of Leuaniua, but none elsewhere and no adults on any island. It is hoped that periodic attention will eliminate the few remaining vectors. In two medical tours of the atoll in 1956, no cases of malaria were discovered. The morale of the people, which had been very low, showed a great improvement after the campaign.

Lachmajer (J.) & Wegner (Z.). **Some Particulars concerning** *Anopheles maculipennis* **in Białowieża.**—*Wiad. parazyt.* **4** no. 5–6 pp. 760–761. Warsaw, 1958. (Also in Polish pp. 759–760.)

The mosquito populations of 20 animal quarters and 20 human dwellings at a place in eastern Poland were surveyed weekly for five months during the summer of 1956. Of 5,057 mosquitos caught, 4,750 belonged to the genus *Anopheles*, and 4,723 of these were *Anopheles maculipennis* Mg. (*messeae* Fln. and *typicus*) and 27 were *A. claviger* (Mg.) (*bifurcatus*, auct.). Anophelines were taken only in the animal quarters, where their numbers fluctuated with time of day, weather, temperature, humidity, etc., and were greatest in mid-June. *Aëdes* appeared rather often in the dwellings. Digestion of the blood-meal by *A. maculipennis* took from 3·5 to 6·5 days, according to the temperature. Activity, as indicated by the number of females that had sucked blood or were hungry, was greatest in May and early June and again in mid-July. Precipitin tests with antisera specific to man, cow, horse, pig and rat indicated that cattle were its usual hosts; although man, horses and pigs were also often available in the morning and evening when the mosquitos were most active, a few positive results were obtained with horse, but none with human serum.

Dissanaike (A. S.), Dissanaike (G. A.), Niles (W. J.) & Surendranathan (R.). **Further Studies on Radioactive Mosquitoes and Filarial Larvae using Autoradiographic Technique.**—*Exp. Parasit.* **6** no. 3 pp. 261–270. 10 figs., 6 refs. New York, N. Y., 1957.

The authors reported in earlier papers [*R.A.E.*, B **46** 129; **47** 67] that they had produced radioactive infective larvae of *Wuchereria bancrofti* by rearing the mosquito hosts (*Culex pipiens fatigans* Wied.) in baths containing

radiophosphorus (^{32}P). However, the degree of activity obtained was inadequate for the study of development in the definitive host, because mosquitos that had been reared in a sufficiently strong radioactive solution did not take a blood-meal. It is here recorded that *C. p. fatigans* was reared from the second instar and *Armigeres obturbans* (Wlk.) from the second or third in baths containing the orthophosphate to give 1 μc. per ml., and five out of 19 females of the former fed on human volunteers infected with *W. bancrofti* and four out of nine of the latter on a cow infected with *Setaria digitata*. Infective filarial larvae of both species with high β-activities were obtained, those of *S. digitata* averaging 174 β-counts per minute. Mortality of the groups of second-instar larvae of *A. obturbans* reared in radioactive baths was high and their development was retarded, but similar groups of *C. p. fatigans* did not differ essentially in these respects from the controls.

The distributions of ^{32}P in mosquitos, pupae and infective filarial larvae were studied by means of autoradiographs and the techniques used are described. The highest amounts of ^{32}P were found in the thoracic region of the male and in the ovarial region of the female mosquito.

Lebied (B.). **Iconographie de l'évolution intrasyncytiale de *Loa loa* chez *Chrysops*. (Note préliminaire sur les facteurs, interne et externe, déterminants du cycle évolutif des Filariata (Scrjabin) chez leurs hôtes intermédiaires).**—*Ann. Soc. belge Méd. trop.* **37** no. 5 pp. 641–645, 2 pls., 3 refs. Brussels, 1957. (With Summaries in Flemish, English, German & Spanish.)

The following is based on the author's summary. The development of *Loa loa* in flies of the genus *Chrysops* is briefly described. It takes place in a polynucleated cell that arises from the fusion of the adipocytes forming the fat-body and encloses one or several microfilariae. Development of *Onchocerca volvulus* in *Simulium* has been found to be similar, but it takes place in thoracic muscle fibres, a pre-existing syncytium [*cf.* also *R.A.E.*, B **24** 155]. The author proposes to demonstrate in a fuller account of the work that this localisation of the developing filariae is brought about by an external and an internal factor, which are also responsible for the completion of the development of the larva or its death.

van Asperen (K.). **The Mode of Action of an Organophosphorus Insecticide (DDVP). Some Experiments and a theoretical Discussion.**—*Ent. exp. appl.* **1** no. 2 pp. 130–137, 1 graph, 10 refs. Amsterdam, 1958. (With a Summary in German.)

Investigations in Holland showed that DDVP (dimethyl 2,2-dichlorovinyl phosphate) is highly toxic to *Musca domestica* L. but much less so to mammals. Vapour concentrations that killed the flies in two minutes were harmless to mice, even after an exposure of six hours, and the LD50's for the flies were 0·18 and 1·5 μg. per g. when DDVP was applied to them by injection and topically, respectively, as compared with 10 and 15 μg. per g. when it was applied to mice by intravenous and subcutaneous injection.

Since it is claimed that organophosphorus compounds act by inhibition of cholinesterase activity in the nervous system, inhibition by DDVP was studied *in vitro*. The results showed a striking correlation between inhibition of mouse-brain cholinesterase and aliesterase and house-fly cholinesterase and aliesterase and toxicity to mice and flies, respectively. The conclusion seemed justified that there was a causal relation between cholinesterase inhibition and toxicity, but the correlation might be due to some other factor, such as more rapid metabolism of DDVP by mammalian tissues and homogenates than by those of flies.

Different susceptibilities of mammalian and house-fly homogenates to inhibition by DDVP do not necessarily indicate that the enzymes differ chemically. The difference might be due, for example, to the presence of other compounds, such as proteins, in the suspensions; these might influence the inhibition values by binding and thus inactivating the DDVP molecules. Possible differences in the cholinesterases of house-flies and mice were therefore investigated. The substrate specificity of house-fly cholinesterase was tested *in vitro* with 12 different substrates, and it was found from the results, which are to be published in full elsewhere, that fly-head cholinesterase shows in general the characteristic properties of " true cholinesterase ", as found in mammalian brain tissue, excess substrate inhibiting the action as far as choline esters are concerned and activity being high against triacetin and extremely low against benzoylcholine. The only deviation was the more rapid hydrolysis of butyrylcholine, which, however, showed the well-known inhibition by excess substrate. Specific differences between the enzymes may therefore exist, but there is no reason to consider house-fly cholinesterase as a special type and large chemical differences are not to be expected.

Further tests were carried out to ascertain whether the differences in inhibition by DDVP are due to structural differences in the enzymes or to other factors present in the homogenates. Homogenates of mouse brain and fly head were prepared, and enzyme inhibition by DDVP was tested with acetylcholine as substrate. It was found that a concentration of 10^{-8}M. DDVP caused 100 per cent. inhibition of fly-head cholinesterase and only about 10 per cent. inhibition of mouse-brain cholinesterase. Mixtures of the two in various proportions were then tested, and the inhibition values obtained were compared with those calculated on two hypotheses, namely, that there is no essential difference between the cholinesterases, the difference in inhibition being caused by the binding of DDVP molecules by other (most probably protein) molecules, and that the difference in susceptibility is due to differences between the enzymes themselves. There was almost complete agreement between the results obtained and those calculated according to the second hypothesis, so that differences in inhibition are probably due, at least in part, to enzyme differences. Some evidence as to the nature of these was obtained, for it was observed in the case of mouse-brain homogenates that there was a slow decrease of inhibition during the first hours after addition of the substrate, whereas there was no such decrease for fly-head homogenates; 50 per cent. reactivation of mouse-brain cholinesterase activity was observed in the course of two hours, so that inhibition of mouse-brain cholinesterase may be slowly reversible, whereas that of fly-head cholinesterase is completely irreversible. The difference in susceptibility to DDVP-inhibition may be partly due to this difference in reversibility.

Bruce (W. N.) & Decker (G. C.). **The Relationship of Stable Fly Abundance to Milk Production in Dairy Cattle.**—*J. econ. Ent.* **51** no. 3 pp. 269–274, 8 graphs, 7 refs. Menasha, Wis., 1958.

Intensive studies on the effect of attack by stable flies (*Stomoxys calcitrans* (L.)) on milk and butterfat production during the summer months (May–September) were carried out by two methods over a period of three years (1955–57) in Illinois. In the split-herd method, half the animals were sprayed daily with an effective repellent and the other half kept as untreated controls. In the whole-herd method, complete herds were treated with repellent sprays chosen to give different levels of protection. Both methods showed a significant correlation between the abundance of stable flies and the rate at which lactation declined. In the split-herd tests, there appeared to be a natural reduction of 22 per cent. in butterfat production not attributable to flies in the period 1st May–30th September, and average additional

losses, attributable to flies, of 1–26 per cent. according to intensity of attack. Butterfat production for the months of July, August and September showed a significantly greater decline in the untreated than in the treated animals, and the difference between their yields increased as the season advanced. The average production loss was estimated to be 0·65 per cent. per fly per cow in the tests with the split herds and 0·7 per cent. in those with the whole herds. Depressed production continued for several weeks after the end of the fly season, and thus good control of stable flies for four months may have beneficial effects for six months or longer. An increase in production of 1 per cent. for six months would repay the cost of spray material, and the results described here suggest that the proper application of good repellent sprays should give an increase of 10–20 per cent.

Cheng (Tien-hsi). **The Effect of Biting Fly Control on Weight Gain in Beef Cattle.**—*J. econ. Ent.* **51** no. 3 pp. 275–278, 2 figs., 2 refs. Menasha, Wis., 1958.

The effect of control of biting flies (which included *Siphona irritans* L., *Stomoxys calcitrans* (L.) and a negligible number of *Tabanus quinquevittatus* (Wied.)) on weight gains in beef cattle [*cf. R.A.E.*, B **47** 30] was investigated in central Pennsylvania in 1957. Sprays that were both insecticidal and repellent were applied in the morning about five days a week to the test animals in a herd at about 75 ml. per animal. A water-base emulsion spray containing 15 per cent. N,N-diethyl-m-toluamide and 1 per cent. methoxy-DDT (methoxychlor), which was used for three weeks, provided effective protection (over 86 per cent. reduction in the mean number of flies per cow per day), and an oil-base spray containing 0·4 per cent. 2,3,4,5-bis (Δ^2-butenylene)-tetrahydrofurfural and 0·035 per cent. pyrethrins with 0·2 per cent. MGK-264 [N-(2-ethylhexyl)bicyclo(2.2.1)-5-heptene-2,3-dicarboximide] (referred to as N-octyl bicycloheptene dicarboximide) and 0·1 per cent. piperonyl butoxide as synergists, used from the fifth to the eighth weeks, was equally satisfactory. Both formulations were much more effective against *Siphona* than against *Stomoxys* [*cf. loc. cit.*]. At the end of the eight weeks, none of the cattle was adversely affected and treated animals had gained an average of 0·5–0·66 lb. per animal per day more than the untreated ones, a significant difference.

Mulla (M. S.) & Barnes (M. M.). **A Twin-rotor Broadcaster for the Application of Granulated Insecticides.**—*J. econ. Ent.* **51** no. 3 pp. 278–281, 1 fig., 9 refs. Menasha, Wis., 1958.

In the course of investigations on the control of eye gnats of the genus *Hippelates* in California, a new type of broadcaster with two four-blade rotors was found to be effective for sheet-type application of insecticides in granular formulations to the surface of the soil. It is powered by a petrol engine and mounted on a jeep. Its advantage is that it allows the provision of uniform deposits of the same material over various swathe widths, or a range of swathe widths with materials which vary in particle density. It is possible to select the position of the feed aperture which will give a uniform deposit on the ground with a particle of a given density. Swathe widths averaging 13–32 ft. were obtained and could be varied by 15–30 per cent. by a variation of rotor speed. The performance of the broadcaster with attapulgite granules varying in mesh size from 15/30 to 30/60, with or without impregnation with aldrin, is described. Coarser formulations gave wider swathes. Impregnation of granules increased swathe width by up to 30–45 per cent. The deposit pattern was slightly less uniform for lighter materials

than for heavier ones, the deposits being somewhat heavier in the centre with the former. Variations of the speed of the jeep between 2 and 7·5 miles per hour or of rates of application between 15 and 100 lb. per acre did not appreciably change swathe width.

Snow (W. E.) & Pickard (E.). **Sampling Methods used to determine the Prevalence of *Mansonia perturbans* during the Evening Peak Period.** —*J. econ. Ent.* **51** no. 3 pp. 320–326, 2 figs., 5 refs. Menasha, Wis., 1958.

The following is largely based on the authors' abstract. Observations on the prevalence of *Mansonia perturbans* (Wlk.) were made during the evening in a lowland pasture area near a swamp in Alabama in the summer of 1957. The standard exposure period was 15 minutes immediately after the 0·9 foot-candle level was reached. Four methods of catching mosquitos near a man during the 15-minute period were used in an attempt to estimate the attacking and non-attacking parts of the immediate population. In three of the methods, mosquitos were caught by the collector with an aspirator on his body and clothing, as well as in a supplementary trapping device (drop net, aerial net or parked car) to account for those still resting or hovering at the end of the period. The fourth method was intermittent aerial net sweeping (about 30 figure-eight sweeps above the head) with no collection of resting mosquitos. The drop-net device consisted of three seven-foot legs connected by spacing rods at the base and supporting a circular frame 43 in. in diameter made of $\frac{1}{4}$-inch iron piping, the whole covered with a folding cloth net and equipped with a trigger mechanism on the inside. The net was sewn, at the open end, to a 44-inch iron ring to provide an abrupt and even descent when the trigger was operated. The aerial nets were 12 in. in diameter and 28 in. long. In the parked-car catches, the interior light of the car was left on and the doors and windows were left open until the end of the period, when they were shut and the trapped mosquitos collected, individuals resting on the interior of the car having been also caught during the collecting period with the aid of a flashlight.

Nine tests were made from 4th June to 10th July inclusive, and 5,637 females and 141 males of *M. perturbans* were taken. The numbers of females and (in brackets) males caught were 2,422 (5) by aspirator and drop-net, 1,242 (5) by the parked-car technique, 1,041 (109) by intermittent aerial sweeping and 932 (22) by the aspirator used with ten terminal aerial sweeps. The aspirator and drop net or parked car yielded the highest numbers of females, largely because they provided confinable resting surfaces for those becoming inactive near the collector during the exposure period. The method with ten aerial sweeps at the end of the period gave the nearest estimate of the hovering remainder of the population, but the numbers varied greatly and appeared to reflect prevailing weather conditions more than population density. Intermittent net sweeping gave the best indication of males in flight and yielded useful background information on female flight activity when biting records were low. Females entered the parked car on moonlit nights and on cool evenings when there was no moon.

Robbins (W. E.), Hopkins (T. L.) & Roth (A. R.). **Application of the colorimetric whole-blood Method to the Measurement of bovine red-blood-cell Cholinesterase Activity.**—*J. econ. Ent.* **51** no. 3 pp. 326–329, 4 graphs, 10 refs. Menasha, Wis., 1958.

The increasing use of organophosphorus insecticides for the control of insects affecting domestic animals and forage crops has resulted in the need

to diagnose poisoning by these anticholinesterase agents. Since the cholinesterase activity of red blood cells can be used as an indicator of that of the nervous system, determination of it would serve as a means of diagnosing poisoning and as a tool in studies of residue ingestion and mode of action. A rapid and precise colorimetric method for the determination of bovine red-blood-cell cholinesterase activity, employing whole blood as the enzyme source, is described. It gives good agreement with the electrometric red-blood-cell method in measuring *in vivo* inhibition by organophosphorus insecticides.

Knipling (E. B.) & Sullivan (W. N.). **The thermal Death Points of several Species of Insects.**—*J. econ. Ent.* **51** no. 3 pp. 344–346, 5 refs. Menasha, Wis., 1958.

To obtain information on the probable fate of insects and other arthropods in closed uninsulated aircraft parked in situations exposed to the sun, in which the heat may be very great, and in unrefrigerated compartments of supersonic aircraft in flight, in which friction on the outer surface may produce enough heat to kill them, various insects of agricultural or medical importance and a tick were exposed for 15–60 minutes to 40–60°C. [104–140°F.] in an electric oven with equal distribution of heat and then observed for 24 hours. Exposure for 15 minutes resulted in complete mortality of *Culex pipiens* L. and *Anopheles quadrimaculatus* Say at 45°C. [113°F.], *Aëdes aegypti* (L.) at 50°C. [122°F.] and *Musca domestica* L. and *Dermacentor variabilis* (Say) at 55°C. [131°F.]. Complete kills of most species were obtained with longer exposures to temperatures lower than these.

Perry (A. S.), Mattson (A. M.) & Buckner (A. J.). **The Metabolism of Heptachlor by resistant and susceptible House Flies.**—*J. econ. Ent.* **51** no. 3 pp. 346–351, 5 graphs, 20 refs. Menasha, Wis., 1958.

Preliminary investigations in 1952 showed that the greater part of a dose of heptachlor absorbed by heptachlor-resistant house-flies [*Musca domestica* L.] was metabolised within 24 hours of application and that the metabolite appeared to be as toxic as the parent compound for susceptible flies. A detailed study of the metabolism of heptachlor and the nature of the metabolite [*cf. R.A.E.*, B **46** 48] was therefore undertaken. Female house-flies of a resistant strain were topically treated with 8–10 μg. heptachlor in 1 μl. benzene. The heptachlor was absorbed fairly rapidly, only 6 per cent. of the applied dose being recovered in an external rinse of n-hexane after seven hours and none after 24 hours. The rinsed flies were macerated with anhydrous sodium sulphate and extracted with ether. The extract was then evaporated, the residue redissolved in n-hexane, and the solution transferred to a chromatographic column which was eluted with n-hexane until 100 ml. had been recovered and then with a 3:1 mixture of n-hexane and benzene until a further 100 ml. had been collected. The hexane portion contained only unchanged heptachlor and the hexane-benzene portion contained only a metabolite. To obtain enough of the metabolite for characterisation, lots of 100–150 flies were treated in a space-spray chamber [**37** 201]. Investigation by colorimetric analysis (using a 1:2 mixture of diethanolamine and 2N methanolic potassium hydroxide as the reagent) showed that the spectrophotometric curve given by the yellow-coloured reaction product of the metabolite was very similar to those of two isomers of synthesised heptachlor epoxide which had melting points of 85–87°C. and 159–160·5°C.,

respectively. When these three substances were tested by topical application to susceptible house-flies, the metabolite, heptachlor and the isomer with the higher melting point showed similar dosage-mortality relations, and the infra-red spectrograms of that isomer were more like those of the fly extract than were those of the other isomer.

Small amounts of the metabolite were recovered two hours after heptachlor had been applied topically and increasing quantities up to 24 hours. After this, amounts remained fairly constant. Three applications of 8·5 μg. heptachlor per female at intervals of 24 hours yielded a corresponding increase in the metabolite in proportion to the cumulative dosage, and mortality rose from 0 per cent. 24 hours after the first application to 40 per cent. 24 hours after the third and to 94 per cent. when the flies were kept for two additional days. Only about half the heptachlor applied was recovered in the form of heptachlor or the epoxide, and analysis of excreta from treated flies yielded no additional material either unchanged or as metabolites. On the other hand, when heptachlor epoxide or the fly extract was applied to resistant flies, 89–98·8 per cent. of it was recovered. The extracted metabolite was considerably more toxic to the resistant flies than the corresponding synthesised epoxide, but the reason for this is not known. The metabolism of heptachlor was studied in susceptible house-flies in the same way as it had been in the resistant strain except that lower dosages were used, and this sometimes necessitated the use of the space-spray technique. Heptachlor epoxide was recovered in significant amounts as early as two hours after treatment and in increasing amounts as more time elapsed. Recoveries varied from 62 to 79 per cent.

The ability of resistant flies to retain large amounts of the epoxide apparently unharmed suggests a mechanism for inactivating it either by making it soluble or by storage in non-sensitive tissue such as the fat-body. It has been shown that heptachlor epoxide accumulates primarily in the fat of heptachlor-fed dogs and rats and in the milk butterfat of the cow, and it was observed that when heptachlor-treated resistant flies were starved after the epoxide had been formed, signs of poisoning appeared. Mortality among treated and control flies after starvation for 48 hours was 70–80 and 20–25 per cent., respectively.

The fact that susceptible house-flies also convert heptachlor to the epoxide suggests that death may result from the action of the latter and not from the direct action of heptachlor. There is a latent period between the application of heptachlor and the onset of symptoms of poisoning, which is not due to slow penetration but coincides with the time needed for the epoxide to appear in sufficient concentration to cause knockdown and eventual death [*cf.* A **40** 160]. Male flies of the resistant strain were considerably more susceptible to heptachlor than females; a dosage of 10 μg. per fly killed 80–90 per cent. of males but no females in 48 hours, yet only 0·2 μg. heptachlor per fly was recovered. However, 4 μg. of the epoxide was recovered per fly, and this dose gave 75–85 per cent. mortality of males experimentally. It is apparent, therefore, that the mortality obtained was due to the epoxide produced. Similarly, the high mortality suffered by resistant females after three repeated applications of 8·5 μg. heptachlor per fly could not have been due to the small amount of heptachlor recovered internally, and may have been caused by the metabolite. The low recoveries obtained after topical applications of heptachlor might be attributable to volatilisation of the compound from the site of application, loss during concentration of the extract or the formation of other metabolites that did not respond to the method of analysis used. It was shown that only 10–15 per cent. could have been lost by volatilisation, and precautions were taken to minimise losses during concentration. There is not as yet adequate evidence of the formation of unknown metabolites.

Graham (O. H.). **Tests with Bayer 21/199 for the Control of Cattle Grubs.** —*J. econ. Ent.* **51** no. 3 pp. 359–360, 3 refs. Menasha, Wis., 1958.

Yearling cattle from South Dakota that had been exposed there to infestation by *Hypoderma lineatum* (Vill.) and *H. bovis* (Deg.) were sprayed on 19th November 1956 in Texas with Bayer 21/199 [O,O-diethyl O-3-chloro-4-methyl-7-coumarinyl phosphorothioate] at 0·25, 0·5 or 0·75 per cent. as a suspension or emulsified solution. As the animals had very thick, water-repellent coats, about 1·5 U.S. gal. spray was applied to each at close range and at a pressure of 300 lb. per sq. in. Of 48 sprayed animals, 46 remained free of encysted larvae throughout the examination season (18th January–26th April), whereas the 16 untreated control animals were all infested with both species and had an average of 44 encysted larvae each. No explanation was found for the failure to obtain complete control on two treated animals, which received the 0·5 per cent. suspension. Eight other animals were given the compound orally on 18th December, four receiving 25 mg. per kg. as a single dose, and the other four 5 mg. per kg. daily for five days. The two groups showed, respectively, 4 and 24 encysted larvae per animal during the season. The failure of these treatments to give complete control may have been due to the later date at which they were made. However, as mild symptoms of toxicity and drastic reductions in blood cholinesterase were noted after them, it is concluded that oral treatment of cattle at 25 mg. per kg. is impracticable. Spray treatments, on the other hand, appear to be a highly practicable method of control if made at the proper time and in a manner to ensure adequate dermal absorption. It has been shown that a single application of a 0·5 per cent. spray may be made without harm to cattle [*cf. R.A.E.*, B **46** 165], but it caused 50 per cent. cholinesterase inhibition in calves 1–2 weeks old, and 0·75 per cent. was a lethal dose for them.

Knapp (F. W.), Terhaar (C. J.) & Roan (C. C.). **Dow ET-57 as a Fly Larvicide.**—*J. econ. Ent.* **51** no. 3 pp. 361–362, 4 refs. Menasha, Wis., 1958.

Few insecticides that have been tested recently for larvicidal activity against *Musca domestica* L. have given control for more than one week [*cf. R.A.E.*, B **45** 178]. Malathion showed considerable promise on some occasions, but not on others [**45** 38, 141; **46** 169]. The tests here reported, which were made in the spring and autumn of 1957 in Kansas, were carried out to determine the effectiveness of Dow ET-57 [O,O-dimethyl O-2,4,5-trichlorophenyl phosphorothioate] against the larvae of *M. domestica* and other flies developing in droppings of caged laying hens. A 25 per cent. ET-57 wettable powder was tested in comparison with a 57 per cent. emulsifiable concentrate of malathion. Each was applied to the droppings in one of the thirds of a poultry house as a 1·25 per cent. spray in water at a rate of 107 ml. per sq. ft., and the remaining third was left unsprayed as the control; the applications were made, at fortnightly intervals, four times in early summer (June and July) and three times during autumn (September and October). Samples of treated material were collected weekly and kept, covered with dry fly-rearing medium, in cups inside wide-mouthed jars, closed with heavy muslin, for three weeks at 80°F.; the flies that emerged were counted and recorded. At the end of the early summer treatments, a general application of 1·25 per cent. ET-57 solution was made as a practical control measure against flies, and before the autumn treatments the poultry house was cleaned and disinfected. In the early summer, ET-57 and (in brackets) malathion gave 89–100 (0–93) per cent. control of *M. domestica* and 97–99 (7–25) per cent. control of all Diptera in the samples collected one

week after treatment and 67–94 (0–17) and 95–99 (3–37) per cent. in the samples collected two weeks after treatment, if one treatment is ignored in which coverage was probably inadequate. Corresponding figures in the autumn were 96–98 (20–57), 97–98 (31–67), 96–98 (0) and 95–98 (0) per cent. *M. domestica* constituted much the greater part of the fly population, except in June. Control by both treatments was lower in the wetter parts of the medium than in the drier. The reason for the very erratic results with malathion is not known.

MITLIN (N.) & BARODY (A. M.). **The Effect of some biologically active Compounds on Growth of House Fly Ovaries.**—*J. econ. Ent.* **51** no. 3 pp. 384–385, 11 refs. Menasha, Wis., 1958.

The possibility of reducing the biotic potential of insect populations by lowering their fertility was demonstrated in work on *Callitroga hominivorax* (Coq.) [*cf. R.A.E.*, B **42** 38, etc.]. The elimination of entire populations [*cf.* **44** 104] is seldom practicable, but as the uninhibited growth of an insect population is exponential, even a small reduction of reproductive potential could reduce massive outbreaks of economic pests. Certain mitotic poisons have been found to inhibit ovarian growth, and consequently oviposition, in *Musca domestica* L. [**46** 117]. In the work described in this paper, three substances of biological origin and 13 synthetic materials, all known to regulate growth, were tested for their effect on the growth of the ovaries of *M. domestica* when administered orally. Ovarian growth was completely inhibited by coumarin, 1-phenyl-2-thiourea, p-quinone, thiourea and piperonyl butoxide, used at 5, 5, 5, 2 and 1 mg. per ml. skimmed milk, respectively, but the other synthetic materials used had no marked effect and the biologically derived substances no effect at all, at the concentrations used. The last were fish ovarian extract, the potassium salt of gibberellic acid (a potent plant growth accelerator derived from the fungus *Gibberella fujikuroi*) and "queen substance" (a hormone-like material secreted by queens of the honey bee that inhibits ovarian growth in attendant worker bees and has been found not to be specific). "Queen substance" was used as an extract in ethanol, in which it has been shown to be readily soluble and relatively stable. Neither it nor the salt of gibberellic acid showed any effect on growth or survival when injected into the flies. Fish ovarian extract did not affect the viability of newly laid eggs left to hatch on impregnated filter paper, nor did gibberellic acid cause any change in growth at any stage when added to the larval medium.

BRUNDRETT (H. M.) & GRAHAM (O. H.). **Bayer 21/199 as a Deterrent to Screw-worm Attack in Sheep.**—*J. econ. Ent.* **51** no. 3 pp. 407–408, 1 ref. Menasha, Wis., 1958.

Incidental observations in Texas having shown that Bayer 21/199 [O,O-diethyl O-3-chloro-4-methyl-7-coumarinyl phosphorothioate] was an excellent contact insecticide against larvae of *Callitroga hominivorax* (Coq.), small-scale tests were made with artificially infested sheep and cattle. These indicated that the compound was highly toxic to larvae of *C. hominivorax*, *Phormia regina* (Mg.) and *C. macellaria* (F.). All larvae present when the animals were sprayed were killed within a few hours, and it appeared that excellent protection was afforded against reinfestation. To evaluate the protection afforded by the compound against infestation of shear cuts by *C. hominivorax* under field conditions, some 11,000 sheep on eight ranches were, immediately after shearing in 1957, treated with sprays of Bayer 21/199 at 0·25 or 0·5 per cent., or by application of EQ-335, a wound dressing

containing 3 per cent. γ BHC (lindane) commonly used at shearing to treat severe cuts. The sprays (generally suspensions of a wettable powder but occasionally emulsions) were applied to groups of 50 sheep or less in small pens at a rate of about 1 U.S. quart per animal and a pressure of 250–350 lb. per sq. in. In addition, 408 sheep and goats on three ranches were treated in the same way for protection against infestation due to other predisposing causes, such as old wounds and injuries associated with lambing and operations. Rainfall was heavy during the tests, and adults of *C. hominivorax* were abundant. Data on the number of animals receiving each of the three treatments at various times on the different ranches and the approximate numbers of cases of infestation developing, as observed by the owners, are shown in a table. There was no evidence of differences in effectiveness between suspensions and emulsions, and results are not given separately. Sprayed animals were protected from infestation for 2–3 weeks, which was an adequate time for most of the injuries to heal at least to a point at which they were no longer attractive as oviposition sites. Sprays protected for at least ten days, whereas the protection afforded by EQ-335 often failed within 2–4 days. The incidence of infestation by *C. hominivorax* was estimated to be 3·8 per 1,000 animals treated with 0·5 per cent. spray, 20·1 per 1,000 treated with 0·25 per cent. spray and 50·5 per 1,000 treated with EQ-335 smear.

Hornstein (I.), Sullivan (W. N.) & Murphy (R.). **Fumigation Properties of Dow ET-57.**—*J. econ. Ent.* **51** no. 3 pp. 408–409, 3 refs. Menasha, Wis., 1958.

A glass-wool filter impregnated with γ BHC (lindane) installed in the air-conditioning system of aircraft was found to release enough vapour for effective fumigation [*R.A.E.*, B **42** 42, etc.]. However, it was felt that even the low concentration so built up might be considered dangerous. An insecticide harmless to man and animals that could be similarly used was therefore sought. Dow ET-57 [O,O-dimethyl O-2,4,5-trichlorophenyl phosphorothioate] was chosen for study and was tested in Maryland in the spring of 1957 in the fuselage (volume about 1800 cu. ft.) of a dismantled aircraft set up out of doors in an unshaded area. A glass-wool air-conditioning filter, measuring 16 × 20 × 1 in. and impregnated with 25 g. ET-57, was mounted on a 16-inch oscillating fan near one end of the fuselage, and normal air exchange was allowed to take place with the doors shut. The fan was turned on two hours before an experiment was begun. In each test, 500–1,000 free-flying house-flies (*Musca domestica* L.) and a similar number of mosquitos (*Aëdes aegypti* (L.)) were exposed to the vapours, in addition to house-flies, mosquitos and cockroaches (*Periplaneta americana* (L.)) in gauze cages and flour beetles (*Tribolium confusum* Duv.) in open petri-dishes. The caged flies and mosquitos were exposed for one hour and mortality was determined after 24 hours, and the cockroaches and beetles were exposed for four hours and mortality was determined after 96 hours. The concentration of ET-57 in the air was determined by a sampling procedure [*cf.* **42** 27] in which the phosphorus present is determined colorimetrically. It increased from 0·03 μg. per litre at 15°C. [59°F.] to 0·09 μg. at 24°C. [75·2°F.] and 1·5 μg. at 45°C. [113°F.], and insecticidal effectiveness also increased with rising temperature. All the house-flies and mosquitos, 19 per cent. of the cockroaches and 53 per cent. of the beetles were killed by the exposures at 25–27°C. [77–80·6°F.]. The lowest temperatures at which all cockroaches and beetles were killed were 33–46°C. [91·4–114·8°F.] and 24–33°C. [75·2–91·4°F.], respectively. All free-flying flies were knocked down in one hour at 25–27°C. and 95 per cent. of mosquitos in three hours at 25–27 and 24–33°C. and 100 per cent. in one hour at 33–46°C. The concentrations of

ET-57 at temperatures above 25°C. may be too high for practical use. Further tests are to be carried out with ET-57 dissolved in a substance designed to reduce its vapour pressure.

McCoy (C. E.). **Suppression of House Fly Breeding in Tomato Cannery Waste Lagoons by means of Polyethylene Cover.**—*J. econ. Ent.* **51** no. 3 pp. 411–412, 1 fig. Menasha, Wis., 1958.

In rural areas of Indiana, wastes from small tomato canneries are commonly disposed of in lagoons, which form breeding places for very large numbers of house-flies (*Musca domestica* L.). The packing season is at its height from late August to early October when fly populations are greatest. An insecticide introduced into the fluid wastes as they leave the plant is so diluted in the lagoon as to be ineffective, and topical application to the organic conglomerate is unsatisfactory because the surface continually cracks and untreated material is exposed to ovipositing flies. In 1957, however, fly breeding was completely stopped at one establishment by covering the lagoon, which was 90 ft. wide and 140 ft. long, with a black polyethylene sheet and piping the wastes into the lagoon under the cover. The edges were secured along the top of the lagoon dike by a layer of earth, and enough slack was left to allow the cover to move up and down with the level of water and wastes. No flies were seen around the lagoon throughout the season, although other plants experienced normal fly problems. Though rainfall was considerably above normal, water never collected on the cover in sufficient quantity to cause it to submerge. Gaseous fermentation products did not collect in sufficient amounts to cause the cover to balloon, and the problem of unpleasant odours emanating from the lagoon was not aggravated. On the assumption that the useful life of the cover would be at least two years, it is estimated that the reduction in applications of residual insecticides allowed by the use of such a cover should make control by this means cheaper than by the use of insecticides alone.

Scott (H. G.). **Control of Mites on Hamsters.**—*J. econ. Ent.* **51** no. 3 pp. 412–413, 3 refs. Menasha, Wis., 1958.

In June 1956, golden hamsters (*Cricetus* (*Mesocricetus*) *auratus*) at a laboratory in Georgia were found to be infested with *Ornithonyssus bacoti* (Hirst) at the rate of about 50 mites each. To control the infestation without affecting the physiology of animals that were being used for a long-term experiment, the removable tray at the bottom of each cage was painted with an emulsion containing 2 per cent. chlordane, and the process repeated each time the cages were washed. No physiological change associated with the chlordane was detected in the hamsters, and the mite population was reduced to about three per animal within two weeks. To control the mites remaining, painting with chlordane was continued and the cages were sprayed after each washing with a solution containing 0·3 per cent. pyrethrins and 1·5 per cent. piperonyl butoxide. Animals not under experiment were dusted with 0·11 per cent. γ BHC (lindane) and 1·91 per cent. methoxy-DDT (methoxychlor), which eliminated the mites. By these means control has been maintained.

Blum (M. S.). **The Toxicities of fluorinated Cyclohexanes to House Flies.**—*J. econ. Ent.* **51** no. 3 pp. 413–414, 11 refs. Menasha, Wis., 1958.

Of eight polyfluorinated cyclohexanes and cyclohexenes tested as insecticides by topical application in acetone solution to females of *Musca domestica* L. at 10 μg. per fly, six caused no mortality and two of the cyclohexanes mortalities of 20 and 10 per cent., 24 hours after treatment. Two (1,2,3,4,5,6-

hexachloro-pentafluoro-cyclohexane and 1,2,3,4,5,6-hexachloro-hexafluoro-cyclohexane) were also found to be inactive when tested in the same way for ability to act as synergists for γ BHC (lindane); application was in equal parts of synergist and toxicant at dosages of 1·25, 2·5, 5 or 10 μg. of each, to females of a strain of *M. domestica*, for which the LD50 of γ BHC was greater than 50 μg. Comparisons are made between the activity of some of the analogues of BHC and their fluorinated counterparts. Whereas Riemschneider found that monofluorination slightly reduces the toxicity of γ BHC [*R.A.E.*, B **40** 17], penta- and hexafluorination completely destroys the insecticidal activity of the isomeric mixture.

GRAHAM (N. P. H.). **Control of Fly Strike in Merino Sheep. The Use of Dieldrin and Aldrin to control Crutch Strike in sucking Lambs and Merino Weaners.**—*Aust. vet. J.* **33** no. 5 pp. 114–118. Sydney, 1957.

Some owners carry out Mules' operation [*R.A.E.*, B **32** 142] on their Merino ewe lambs at marking time, but others prefer to wait until the sheep are 6–9 months old. Three field trials were carried out in 1953–54 to assess the value of dieldrin and aldrin for protecting these young susceptible sheep against crutch strike during the period of waiting. In the first trial, designed to determine whether treatment at the time of marking would give protection during the suckling period, 0·1, 0·2 or 0·3 per cent. dieldrin or 0·3 per cent. aldrin, in emulsified solution, was applied by jetting to the crutch area and a strip above the tail, immediately after the tails had been docked. Decreased run-off at the higher concentration, because of the presence of more wetting agent, enabled the dosage to be reduced so that the higher cost of the emulsion was largely offset. As a long dry period with no blowfly activity followed treatment, the duration of complete protection could not be accurately assessed. The percentages of lambs susceptible after 17 weeks were 52, 50, 43 and 44, respectively, in the four treatments, and the percentages struck were 32, 31, 12·4 and 14, and most of the strikes were small, particularly in lambs receiving 0·3 per cent. dieldrin; in the control lambs a higher percentage was struck, and many of the strikes were very extensive.

The other trials concerned the protection that would be given to weaned ewe lambs by dieldrin and aldrin applied by jetting at 0·2 gal. per sheep to the crutch area and a band above the tail. In one, the percentage of dieldrin or aldrin used was 0·05 and the percentages of sheep struck in 14 weeks were 14 and 27, respectively, as compared with 46 in those not treated. There was virtually no fly activity for the first nine weeks. Strikes were found on aldrin-treated sheep immediately after this and on dieldrin-treated ones a week later. In the other, treatment was with 0·025, 0·1 or 0·15 per cent. dieldrin or 0·1 per cent. aldrin. The incidence of strike in all the treated groups was very low, but aldrin was again inferior to dieldrin, giving similar results at 0·1 per cent. to dieldrin at 0·025 per cent. [*cf.* **45** 209; **47** 49]. There was no clear evidence in the tests that increasing the concentration of dieldrin appreciably lengthened the period of complete protection, but it reduced the incidence of strike during the period of partial protection, and during this period dieldrin always reduced strike more than did equal concentrations of aldrin.

MURRAY (M. D.). **A preliminary Note on the Efficiency of some of the new Insecticides against** *Psorergates ovis*, **the Itch Mite of Sheep.**—*Aust. vet. J.* **33** no. 5 pp. 122–123, 2 refs. Sydney, 1957.

Estimates of the effectiveness of various chlorinated hydrocarbon and organic phosphorus insecticides against *Psorergates ovis* Womersley were

obtained in patch tests, in which the fleece on about one sq. ft. of the body of an infested sheep is clipped to within half an inch of the skin, a skin scraping from the centre of the clipped area is examined and the area is saturated with the test insecticide. To evaluate lasting effectiveness, one insecticide is tested on each animal and scrapings are examined periodically. In screening tests, several insecticides are tested on one sheep and effectiveness is estimated by examination of a skin scraping on the second day. Only sheep carrying heavy infestations are suitable, and as the immature stages of the mite are spent in a protected position under the horny layer of the skin, whereas the adults wander over the surface, at least half the mites in a skin scraping should be immature. In the tests described, as few heavily infested sheep were available, the screening technique was used. Results were classified as satisfactory when none or only one of the mites in the scraping was living on the second day. With insecticides or concentrations that were considered unsatisfactory, the percentage of dead mites in the scrapings seldom exceeded 50. Compounds giving satisfactory kill were δ BHC and Thiodan [6,7,8,9,10,10-hexachloro-1,5,5a,6,9,9a-hexahydro-6,9-methano-2,4,3-benzodioxathiepin-3-oxide] at 0·5 per cent., malathion at 0·2 per cent., and diazinon [O,O-diethyl O-2-isopropyl-4-methyl-6-pyrimidinyl phosphorothioate] and Dipterex (L 13/59 [dimethyl 2,2,2-trichloro-1-hydroxyethylphosphonate]) at 0·01 per cent. Unsatisfactory ones were δ BHC and Thiodan at 0·1 per cent., aldrin at 0·5 per cent., malathion at 0·01 per cent. and diazinon at 0·005 per cent. Moreover, in small-scale tests, malathion and diazinon killed adults and emerging nymphs of *Damalinia ovis* (Schr.) at 0·001 per cent. and diazinon also killed adults, emerging adults and pupae of *Melophagus ovinus* (L.) at the same concentration. Diazinon has been shown to protect sheep against blowflies for a longer period than aldrin or dieldrin [*R.A.E.*, B **47** 129], although malathion did not protect them for so long. The organic phosphorus insecticides as a group thus appear promising for the control of all the chief ectoparasites of sheep in Australia. Though there may be some risk to domestic animals and man from their use under certain circumstances because they inhibit irreversibly the activity of cholinesterase, there should be no serious risk at the concentrations likely to be used on livestock, provided ordinary precautions are taken. There was no evidence that mites were killed by subcutaneous injection of γ BHC or dieldrin into sheep at 100 mg. per kg. body weight.

Browne (L. B.). **The Frequency of Mating of the Australian Sheep Blowfly,** *Lucilia cuprina*.—*Aust. J. Sci.* **20** no. 6 p. 185, 1 ref. Sydney, 1958.

The eradication of *Callitroga hominivorax* (Coq.) from Curaçao by the release of large numbers of sterile males [*R.A.E.*, B **44** 104] was greatly facilitated by the habit of the females of this species of mating only once [**40** 43]. Evidence is here given that the females of the Australian sheep blowfly, *Lucilia cuprina* (Wied.), probably also mate only once. Experiments were carried out in a glasshouse at 25°C. [77°F.] with flies that had emerged in separate tubes. When four virgin females or four females that had mated previously were put in cages with four males four days old, and observed for one hour, the virgin females mated readily, copulation generally beginning within 15 minutes, but females five days old that had mated on the previous day did not mate during the hour and only a few that had mated three or seven days earlier did so. Virgin females ten days old mated more readily than mated females of the same age, but somewhat less readily than unmated females four days old. When one female was caged with four males for one hour, virgin females almost always mated at the first attempt

by a male, but mated females repelled attempts, usually successfully. In a test in which two cages, each with eight virgin females and one male, were observed for 1¼ hours, both males mated with three females in succession during the observation period; the copulations lasted 10–14½ minutes. In each instance, spermatozoa were subsequently found in the spermathecae.

HATCH (C.). **Effect of Fleece Contaminants on Activity of nine Blow Fly Larvicides.**—*Irish vet. J.* **11** no. 9 pp. 170–188, 12 refs. Dublin, 1957.

As it has sometimes been observed that insecticides do not give protection for so long against breech strike as against body strike of sheep, a series of laboratory tests was carried out to determine whether faeces or urine had any inhibitory effect on the larvicidal activity of nine chlorinated-hydrocarbon compounds. All the compounds were in the form of wettable powders, and the minimum concentration of each that could kill or adversely affect first-instar larvae of *Phormia regina* (Mg.) was determined when the larvae were kept in continuous contact with a suspension of the larvicide in a nutritional medium that also contained ovine faeces or bovine urine, and with a similar suspension in which faeces and urine were replaced by distilled water. The results are given in tables and discussed. The presence of faeces inhibited the larvicidal activity of DDT, raising the highest concentration in the presence of which growth proceeded normally from 4 to 16 parts per million under the conditions of the experiment and the lowest concentration that would give complete kill from 16 to 64 p.p.m. It did not greatly affect the speed of action of the DDT. The presence of faeces did not inhibit the larvicidal activity of ethyl-DDD (Perthane [1,1-di(p-ethylphenyl)-2,2-dichloroethane]), methoxy-DDT (methoxychlor), aldrin, dieldrin or toxaphene. It did not always inhibit the effect of BHC, γ BHC (lindane) and chlordane, and in the case of these three the evidence was not conclusive. The presence of urine did not inhibit the larvicidal activity of any of the compounds but may slightly have assisted that of some.

PESSÔA (S. B.). **Parasitologia médica.** [Medical Parasitology.]—5th edn. (revd.), 10¼ × 7 in., 1124 pp., 3 col. pls., 568 figs., 1 fldg. table, 19 pp. refs. Rio de Janeiro, Livr. Edit. Guanabara, Koogan S. A., 1958.

This fifth edition of a textbook of which two earlier editions have already been noticed [*R.A.E.*, B **36** 73; **37** 234] is the same as these in arrangement and scope but has been further revised and enlarged to bring the information up to date.

PAPERS NOTICED BY TITLE ONLY.

Opinion 547. Designation under the Plenary Powers of a type species [*Anopheles maculipennis* Meigen, 1818] **in harmony with accustomed usage for the nominal genus** *Anopheles* **Meigen, 1818 (Class Insecta, Order Diptera).**—*Opin. int. Comm. zool. Nom.* **20** pt. 14 pp. 153–163. London, 1959.

Opinion 550. Suppression under the Plenary Powers of the generic name *Taeniorhynchus* **Lynch-Arribálzaga, 1891, for the purpose of protecting the generic name** *Mansonia* **Blanchard, 1901 (Class Insecta, Order Diptera) and matters relating to other names in the same Class and in the Class Aves incidental thereto.**—*Opin. int. Comm. zool. Nom.* **20** pt. 17 pp. 185–198. London, 1959.

Liles (J. N.). **Some Effects of dietary Penicillin on the German Cockroach, *Blattella germanica* (L.) (Orthoptera Blattidae).**—*Ohio J. Sci.* **58** no. 2 pp. 84–96, 5 figs., 10 refs. Columbus, Ohio, 1958.

The following is substantially the author's summary. Some effects of the oral administration of penicillin on *Blattella germanica* (L.) were studied [*cf. R.A.E.*, B **44** 57; **46** 25]. A penicillin was added to a diet of dog-food at 15 different concentrations ranging from 6 to 100,000 parts per million, and the insects were fed on the various diets all their lives and through two successive generations. In the first generation, growth (as measured by weight) appeared to be unaffected if the diet did not contain more than about 400 p.p.m. penicillin, but was significantly inhibited after the fourth week at 780 p.p.m. or more, and increasingly so as concentrations rose to 100,000 p.p.m. In the second generation, the offspring of the cockroaches that received as little as 50 p.p.m. showed reduced growth rates, whether they were reared on the control or the parental diet. First-generation cockroaches receiving diets containing less than 780 p.p.m. penicillin reached the adult stage in about the same length of time as controls, but on diets containing 780 p.p.m. or more the time taken to reach the adult stage was related inversely to the growth rate; cockroaches on all diets moulted to the adult stage at approximately the same weight, so that higher doses of penicillin did not result in smaller adults but in a delay in development to the adult stage. Offspring from first-generation adults that had received 50 p.p.m. penicillin or more needed longer to reach the adult stage than did the controls, whether they received the parental or the control diet. Mortality among the first-generation test cockroaches was not appreciably higher than that among the controls, even at the highest penicillin concentrations, but second-generation cockroaches showed higher mortality than the controls if their parents received as little as 100–200 p.p.m. penicillin. The reproductive capacity of the first generation was apparently reduced by 200 p.p.m. penicillin or more, and no egg capsules were produced by those females receiving the diet containing 100,000 p.p.m. Offspring of first-generation parents receiving the diet containing 50 p.p.m. or more showed reduced reproductive capacity, whether or not they themselves received penicillin. Cockroaches of the second generation were much more adversely affected than those of the first in all respects.

Simmons (S. W.). Ed. **DDT. The Insecticide Dichlorodiphenyltrichloroethane and its Significance. Das Insektizid Dichlordiphenyltrichloräthan und seine Bedeutung. Vol. II. Human and Veterinary Medicine.**—*Lehrb. Monogr. Geb. exakt. Wiss., chem. Reihe* **10** 9½ × 6¾ ins., 570 pp., illus., many refs. Basle & Stuttgart, Birkhäuser Verlag, 1959. Price *Sw. Fr.* or *DM.* 66.00.

This second of a proposed series of three volumes on the development and uses of DDT, under the general editorship of P. Müller [*cf. R.A.E.*, B **44** 134], is entirely in English and comprises three critical reviews of information on aspects of the use of DDT connected with the control of pests and arthropod-borne diseases of man and animals.

In **Pharmacology and Toxicology of DDT** (pp. 9–247, 15 figs., 685 refs.), W. J. Hayes jr. reviews data on the clinical, pathological and physiological effects of DDT in vertebrates and on the dosage-mortality relationships established, on its metabolism to other compounds in them, on the toxicity of DDT to man (as observed in intentional experimental exposure, in accidental poisoning and in the course of ordinary use), on the hazards to which workers are exposed and the dangers arising from deposits in animal and

vegetable products and in water and means of reducing them, on protection from excessive exposure, and on hazards to domestic mammals and birds, to silkworms and bees and to wildlife. Reference is made to a few attempts to use DDT for the control of undesirable vertebrates.

In **The Use of DDT Insecticides in Human Medicine** (pp. 249–502, 33 figs., 668 refs.), Simmons reviews the use of DDT for the control of the arthropod vectors of human disease in various parts of the world and the effect of vector control on the incidence of the diseases (the control of Anophelines, *Pediculus humanus humanus* L. (*P. h. corporis* Deg.) and *Xenopsylla cheopis* (Roths.) and the effect of this on malaria and epidemic and endemic typhus, respectively, being dealt with in particular detail). The incidence of intestinal diseases in regions in which populations of flies, notably *Musca domestica* L., have been controlled by DDT and in those in which they have not is also compared, and its use against pest insects (*Cimex*, cockroaches, fleas, flies and mosquitos) and to control insects in aircraft and ships, and the various aspects of resistance to it among arthropods of public-health importance are also reviewed.

In **The Use of DDT in Veterinary Medicine** (pp. 503–570, 15 figs., 203 refs.), E. F. Knipling discusses very briefly the toxicity of DDT to mammals in relation to its use in veterinary work, the types of formulations used in this work and methods of applying them, and deals more fully with the control of specific arthropod pests of domestic animals.

Wilson (H. G.) & Labrecque (G. C.). **Tests with Organophosphorus Compounds as House Fly Larvicides in Poultry Houses.**—*Florida Ent.* **41** no. 1 pp. 5–7, 2 refs. Gainesville, Fla., 1958.

Piles of droppings that accumulate in fowl houses in Florida become suitable for the breeding of *Musca domestica* L. and other flies if they become moist, and the resulting liquefaction of the mass renders it a still more favourable breeding medium. Emulsion sprays to control breeding also cause liquefaction [*cf. R.A.E.*, B **46** 169], and dusts disturb the birds. Tests were therefore carried out with phosphorus insecticides in small quantities of kerosene (150 g. in 1–2 U.S. gal. and 300 g. in 2 U.S. gal. per 1,000 sq. ft.). At either rate, diazinon [O,O-diethyl O-2-isopropyl-4-methyl-6-pyrimidinyl phosphorothioate], Dipterex [dimethyl 2,2,2-trichloro-1-hydroxyethylphosphonate], Dow ET-57 [O,O-dimethyl O-2,4,5-trichlorophenyl phosphorothioate] and malathion [**47** 138] all gave good control of *M. domestica* after two days in one or more tests and all failed to give control after a week in some tests. Diazinon was the most effective larvicide after a week. There was no liquefaction of the manure.

Dremova (V. P.). **On the Factors determining the Distribution of *Musca domestica* L. in Rooms and the Exchange of Population between Rooms and the Street.** [*In Russian.*]—*Zool. Zh.* **36** pt. 4 pp. 561–568, 3 figs., 24 refs. Moscow, 1957. (With a Summary in English.)

A knowledge of the factors that regulate the movements of *Musca domestica* L. would facilitate control of the flies by insecticide deposits in houses. In addition to the migration between sources of food and suitable breeding places, which is determined physiologically, there is also a movement in search of optimum physical conditions. Factors determining this were investigated in the laboratory and in buildings and the open in various parts of the Soviet Union. It was found that the chief factor in the horizontal and vertical distribution of the flies in rooms is the temperature. Within the

range of 13–32°C. [55·4–89·6°F.], the higher temperatures were preferred, and as the microclimate of rooms is continually changing, this leads to local movements of the flies. The higher the temperature, the lower the parts of rooms in which the flies congregated. Electric light had a stimulating effect, except on hungry flies. The flight into and out of houses was determined similarly, the flies showing a tendency to seek higher temperatures and reduced atmospheric humidity. Of the flies entering houses, 64·8 per cent. were in need of food, and up to 90·4 per cent. of the females belonging to this group had under-developed ovaries. Of those flying out, up to 79·4 per cent. had ovaries in an advanced stage of development. The results indicate that deposit insecticides should be applied to the whole of a room and not to one part only.

Zhordaniya-Rapava (T. K.). **On the natural Nidality of Caucasian Tick-borne Relapsing Fever in Georgia.** [*In Russian.*]—*Zool. Zh.* **36** pt. 4 pp. 622–625. Moscow, 1957. (With a Summary in English.)

In investigations in Georgia in 1949–54, relapsing-fever spirochaetes were found in jackals (*Thos aureus*) in hilly-mountain and hilly-steppe districts and in a reptile, *Agama caucasica*, in rocky areas, ravines and ruined buildings. They were also found in examples of *Ornithodoros verrucosus* Olen., Zas. & Fen. associated with these animals and with foxes (*Vulpes vulpes alpherakyi*) and occasionally in those associated with badgers (*Meles meles minor*).

Belozerov (V. N.). **The Use of Dimethyl Phthalate as a Repellent against the Rat Mite.** [*In Russian.*]—*Zool. Zh.* **36** pt. 4 pp. 625–628, 1 fig., 13 refs. Moscow, 1957. (With a Summary in English.)

The author records experiments showing that *Ornithonyssus* (*Bdellonyssus*) *bacoti* (Hirst) is repelled for up to 24 hours by a 20 per cent. alcohol solution of dimethyl phthalate applied to the skin of white mice. The mites were not repelled when their first pair of legs had been amputated, and this indicates the presence of olfactory receptors on these.

Lebedev (A. D.). **The Ecology of the Tick** *Dermacentor pictus* **Herm. on the Basis of Observations carried out in the Forest-steppe of western Siberia.** [*In Russian.*]—*Zool. Zh.* **36** pt. 7 pp. 1016–1025, 1 graph, 14 refs. Moscow, 1957. (With a Summary in English.)

Of the four species of Ixodids that occur in the forest-steppe region of western Siberia, *Dermacentor pictus* (Herm.) is by far the most numerous and the only one that attacks man to any extent. A list is given of 14 species of small mammals on which the larvae and nymphs of this tick were found feeding, together with information on the times of year at which these stages were found and their host preferences. The adults occurred in a variety of habitats. They attacked cattle in May and June and again in July–August, and were also observed on man, though they did not become firmly attached, seldom fed to repletion and fell off rapidly. The importance of this tick in the transmission of diseases of man is briefly discussed [*cf. R.A.E.*, B **44** 148, 151, 152], and general recommendations for control by removing the ticks from domestic animals and burning the grass beneath clumps of birch trees, which are preferred habitats, are made.

Pavlovskiĭ (E. N.) & Skrȳnnik (A. N.). **The Effect of Ultraviolet Rays on Ticks, *Ornithodorus papillipes*, infected with the Spirochaetes of Relapsing Fever.** [*In Russian.*]—*Zool. Zh.* **36** pt. 11 pp. 1673–1682, 1 pl., 2 figs., 21 refs. Moscow, 1957. (With a Summary in English.)

Details are given of experiments in which larvae, nymphs and adults of *Ornithodoros tholozani* (Lab. & Mégn.) (*papillipes* (Bir.)) infected with relapsing-fever spirochaetes were exposed to ultraviolet rays from a bactericidal lamp. The treatment had various effects on the ticks, killing some and causing malformations, usually of the legs, after moulting in others, but none on the spirochaetes in them.

Breland (O. P.). **A Report on *Haemagogus* Mosquitoes in the United States with Notes on Identification (Diptera: Culicidae).**—*Ann. ent. Soc. Amer.* **51** no. 3 pp. 217–221, 2 figs., 13 refs. Washington, D.C., 1958.

Haemagogus equinus Theo., from which yellow-fever virus was recently recovered in nature [*R.A.E.*, B **47** 94], and which has transmitted the virus in the laboratory [*cf.* **39** 71; **40** 115; **47** 58, etc.] and bites man, has recently been found to occur near Brownsville, Texas [*cf.* **45** 34]. As its presence in the United States might favour the reintroduction of yellow fever, a study of its status there was made in 1956 and 1957. Some 190 collections of material were made from more than 100 tree holes along the 800 miles of the Texas–Mexico border, and immature stages of mosquitos were found in 55 of them, but *H. equinus* was found only six times, always in the Brownsville area, where it seems to be well established. However, the numbers found were always small.

Three of the collections containing *H. equinus* were made in April, June and July 1957 from the same cavity in a hackberry tree (*Celtis* sp.) and the others in Texas ebony (*Pithecolobium flexicaule*). All collections were made in areas of dense vegetation. All the cavities were 7 ft. or less from the ground and most had relatively small openings. Exposure of human bait in localities in which larvae had been collected and several light-trap catches failed to yield any adults. A key for separating all mosquito larvae known to occur in tree holes in the eastern half of the United States is given, and the characters are discussed that distinguish the larvae of *H. equinus* from those of other mosquitos, and the adults from those of the species of *Psorophora*, in the area studied.

Tarshis (I. B.). **A preliminary Study on Feeding *Ornithodoros savignyi* (Audouin) on human Blood through Animal-derived Membranes (Acarina: Argasidae).**—*Ann. ent. Soc. Amer.* **51** no. 3 pp. 294–299, 4 figs., 18 refs. Washington, D. C., 1958.

The following is almost entirely based on the author's summary. An apparatus and a technique are described for the *in vitro* feeding of *Ornithodoros savignyi* (Aud.) through animal-derived membranes on citrated whole human blood. The apparatus consists of a thermostatically controlled water bath, a chamber to hold the blood and a feeding chamber, to which the membrane is attached, to hold the ticks; blood that had been stored at 4°C. [39·2°F.] was used. When ticks were tested on nine membranes, prepared from bovine or ovine caecum or bovine intestines, the percentages that fed varied from 0 to 38·8, but when the skin of a mouse or cottontail rabbit [*Sylvilagus*] was used, the percentages were 95·5 and 92·4, respectively.

These membranes could be used a number of times without lowering the proportion of ticks feeding and could be prepared in advance and stored in a refrigerator for several months. Results were best at blood temperatures of 34–35°C. [93·2–95°F.] and ambient temperatures of 26–30°C. [78·8–86°F.]. The ticks fed equally well in the morning or afternoon and in light or dark rooms. Once established on the membranes, nymphs could engorge in 5 minutes and adults in 5–15 minutes. Coxal fluid was expelled copiously by fully engorged ticks about 1–5 minutes after the meal, and continued to flow intermittently for as long as 60 minutes. The presence of large amounts within the membrane chamber did not deter the ticks from feeding, nor did crowding in the chamber.

Kitaoka (S.) & Yajima (A.). **Effects of Insecticides on Ticks. I. Inhibitory Dosage to the Development and Change of the Resistance during Blood-sucking.** [*In Japanese.*]—*Jap. J. appl. Ent. Zool.* **1** no. 4 pp. 254–258, 2 graphs, 22 refs. Tokyo, 1957. (With a Summary in English.)

In tests on *Boophilus microplus* (Can.) (*caudatus* (Neum.)), in which γ BHC, allethrin and p,p′DDT were applied topically to adult females with an average body length of 6·1 mm., to determine the dosage necessary to inhibit feeding and that lethal to detached ticks, doses of 2·05, 68·5 and 385 μg., respectively, per tick caused 50 per cent. drop of feeding ticks in the rapidly developing phase, whereas similar application of 1 mg. α BHC had no effect. No correlation was observed between cuticle thickness and resistance to BHC, but comparison of inhibitory and lethal dosages indicated that engorged ticks were about a million times as resistant as unfed ones, and it is concluded that chemical control is more effective against ticks that are unfed or at an early stage of feeding.

Gillies (M. T.). **Notes on the Biology of a new Subspecies of *Anopheles wellcomei* (Diptera: Culicidae) from East Africa, and on the Distribution of related Forms.**—*Proc. R. ent. Soc. Lond.* (A) **33** pt. 1–3 pp. 9–14, 9 figs., 11 refs. London, 1958.

Distinguishing characters are given for the adults of both sexes and the egg of *Anopheles wellcomei crepens*, subsp. n., which occurs as a group of allopatric populations in the southward extension of the Somali arid zone in Kenya and northern Tanganyika. The larva and pupa are indistinguishable from those of the typical form. Recent distribution records are given for the latter and for *A. distinctus* (Newst. & Cart.); a single female, captured biting man in Zanzibar, is briefly described as an undetermined subspecies of *A. wellcomei* Theo., and the recorded distributions of *A. wellcomei wellcomei*, *A. wellcomei crepens* and *A. distinctus* are shown on a map. *A. distinctus* is not known to occur farther north than southern Tanganyika; its distribution overlaps that of typical *A. wellcomei* in the Belgian Congo and Northern Rhodesia. *A. wellcomei* is widely distributed over Africa and appears to reach its maximum abundance in the dry savannah regions, the typical form being common throughout the Sudan savannah zone.

A. w. crepens is particularly common in the rain-shadow area between the Usambara and Pare Mountains, and is most abundant from May to August after the main rainy season. Larvae have been found in permanent and semi-permanent swamps and streams in the South Pare District of Tanganyika. They rest on the stems of emergent plants a little above the main water surface and particularly favour isolated clumps. Few are obtained by the normal method of collecting with a bowl lowered carefully into the

water so as to cause as little disturbance as possible, but if the bowl is put in with a splash, many of the larvae dislodged by the movement float into it. Females have often been caught biting man at night, generally but not exclusively outside, but they have been taken in greatest abundance biting cattle in the open or resting around thorn animal-enclosures at night. No gland infections were found among 127 dissected for malaria parasites in South Pare District. A. Smith observed females of this subspecies biting man in large numbers near the Ruvu River in northern Tanganyika, even after house spraying had been carried out. The author concludes that, though it could not be an important vector of malaria in the presence of more potent ones, it might be able to maintain low-grade transmission out of doors in areas in which it is locally abundant. This possibility should be particularly borne in mind if house spraying has failed to eliminate the disease.

In 1955, J. D. Gillett described the male of the form originally designated *A. distinctus* var. *ugandae* by Evans [*R.A.E.*, B **23** 58] and showed that, on characters of the genitalia, this form was more closely related to *wellcomei* than to *distinctus*. As both it and so-called "dark forms" of *wellcomei* differ from the typical form only in the amount of pale scaling on the palps and proboscis, and the amount of pale scaling on both these appendages is highly variable in *erepens*, the author considers that both *ugandae* and the "dark forms" should be regarded as falling within the range of variation of typical *wellcomei*.

McClelland (G. A. H.). **Observations on the Mosquito, *Aëdes* (*Stegomyia*) *aegypti* (L.), in East Africa. I. The Biting Cycle in an outdoor Population at Entebbe, Uganda.**—*Bull. ent. Res.* **50** pt. 2 pp. 227–235, 1 graph, 13 refs. London, 1959.

Well-defined cyclical biting activity has been found to occur in various species of *Aëdes* of the subgenus *Stegomyia* [*cf. R.A.E.*, B **33** 190; **37** 177], but the little work so far done on the biting activity of *A. aegypti* (L.) has given somewhat conflicting results [**44** 6; **46** 29–30; **47** 22]. Ten 24-hour catches, on human bait, were made in the Entebbe area of Uganda, at a site in a strip of forest varying in width from 0 to 300 metres and situated between a swamp and an area of mixed peasant cultivation; here the population of *A. aegypti* consisted mainly of subsp. *formosus* (Wlk.) [**47** 19]. The catches showed a sharply defined biting cycle, corresponding closely to a diurnal cycle of flight activity observed over three consecutive days. Almost two-thirds of the biting activity occurred during the main peak period in the three hours before sunset, and 7 per cent. in a subsidiary peak period in the third hour after sunrise. These four hours were the only ones in which males were taken alighting on the bait. The remaining hours of daylight and the first hour after sunset accounted for nearly all the rest of the biting activity, only 1 per cent. occurring at night. Swarming occurred during the main peak of flight activity, ½–1½ hours before sunset. These findings are consistent with those of workers in Kenya [**44** 6; **47** 22] in plantations but not with their findings inside and near houses. In their work the forms of *A. aegypti* were not distinguished, but it is thought that subsp. *formosus* probably predominated in the plantations. The various results taken together suggest that when the behaviour of outdoor and indoor populations is being compared, a distinction should be made between this subspecies and the other two forms in which no similar cycle has yet been demonstrated. The biting cycle of subsp. *formosus*, which is thought to be the wildest form [**47** 20], is similar to that of *A. africanus* (Theo.), a related forest species [**37** 177], and Gillett & Haddow found the same resemblance between the oviposition curves of *A. africanus* and *A. aegypti* [**46** 192]; the latter species

was, in their work, apparently represented by a mixture of subsp. *formosus* and the type form.

Ford (J.), Glasgow (J. P.), Johns (D. L.) & Welch (J. R.). **Transect Fly-rounds in Field Studies of** *Glossina*.—*Bull. ent. Res.* **50** pt. 2 pp. 275–285, 3 figs., 8 refs. London, 1959.

The following is almost entirely based on the authors' summary. The fly-round has long been regarded as the most satisfactory way of following fluctuations in populations of tsetse flies (*Glossina*) and locating areas of concentration. It consists of a path cut through bush so as to traverse the principal vegetation communities and is divided into sections, corresponding to the latter, on each of which the flies are caught. A modification now widely used but not previously described in detail is termed a line transect or transect fly-round; this follows an arbitrary course along straight lines that may be orientated with regard to the topography and is divided into numerous short sections of equal length ending at posts at which flies are caught. In its simplest form, it follows a straight course, but various patterns are used, including an angular spiral. It facilitates the collection of quantitative data on tsetse density and the factors (such as vegetation) that affect it, and their analysis is possible in more detail than was the case when the fly-round was laid out according to a preconceived notion of vegetational relationships. This is illustrated by data from a fly-round at Shinyanga, Tanganyika, consisting of six sides, each of 2,000 yd., of two diagonally adjoining squares, that was divided originally into nine sections of varying lengths representing the floristic communities traversed, and subsequently into 120 sections each 100 yd. long. Comparison of the catches of non-teneral males of *G. swynnertoni* Aust. grouped according to the two methods emphasises the much greater detail provided by the second of them. The transect fly-round is easy to lay out and operate and is thought likely to be particularly useful in connection with reclamation work.

The effect of varying the section length was investigated for *G. swynnertoni* at Shinyanga, *G. pallidipes* Aust. in Nyanza Province, Kenya, and *G. austeni* Newst. in Zanzibar. With the first, progressively fewer flies of all categories except teneral males were caught as the section length was increased progressively from 50 to 200 yd., with the other species a similar tendency was apparent, but not significant. The results emphasise that data from fly-rounds reflect, in part, the reaction of tsetse populations to the behaviour of the catching party. When considering availability [*R.A.E.*, B **44** 116], this reaction must be taken into account as a third variable element, additional to density and activity. Catches of *G. pallidipes* on a fly-round carried out daily for a month showed differences on consecutive days, sometimes exceeding 3:1, that must be due to factors influencing availability and do not represent changes in absolute population.

Data from the transect fly-round can be analysed so as to indicate sections in which the catches deviate significantly from those expected on the assumption that they are distributed according to a Poisson series, and in which there may thus be presumed to be areas of concentration of the population, or the reverse. A table is provided to facilitate such analysis.

Jarman (R. T.). **The Deposition of Airborne Droplets on dead House-flies (*Musca domestica* L.).**—*Bull. ent. Res.* **50** pt. 2 pp. 327–332, 1 graph, 14 refs. London, 1959.

The following is almost entirely the author's summary. In the laboratory study of the deposition of droplets on dead house-flies (*Musca domestica* L.)

that is described in this paper, a spinning-top sprayer was used to produce a spray of uniformly sized oil droplets and a cascade impactor to measure the concentration of the spray of droplets, which were dyed. The deposits obtained on a dead house-fly in flying posture and a cascade-impactor slide when these were exposed in turn for fixed periods to a wind of 1 metre per second in a wind tunnel were compared colorimetrically, and determinations were thus made of the collection efficiency of the flies. This is defined as the volume of liquid deposited on an object, expressed as a percentage of the volume that would have passed through the same cross-sectional area as that of the object, had the latter not been there. The measured collecting efficiency of a fly varied from about 70 per cent. (when the droplet diameter was 27 μ) to about 200 per cent. (droplet diameter 75 μ), and was about twice that of a sphere with a cross-sectional area twice the projected frontal area of the fly. From theoretical calculations of the filtering effect of different elements of the vegetation, it is concluded that the optimum droplet diameter for deposition on flies in woodland is 20–40 μ.

Burden (G. S.), Lofgren (C. S.) & Eastin (J. L.). **Malathion Resistance in a Laboratory Strain of the German Cockroach.**—*Pest Control* **27** no. 2 p. 38, 3 refs. Painesville, Ohio, 1959.

Since *Blattella germanica* (L.) has developed resistance in the United States to the chlorinated-hydrocarbon insecticides [*R.A.E.*, B **41** 179] and pyrethrins [**46** 33], several organophosphorus compounds have been used successfully for its control. To investigate the likelihood of the development of resistance to this group of insecticides also, nymphs of a susceptible colony were exposed to contact sprays of malathion in deodorised kerosene in a wind tunnel, and nymphs of each succeeding generation bred from the survivors were similarly exposed. The concentrations of malathion needed to maintain a mortality of 30–60 per cent. were 1, 2 and 4 per cent. for the F_1–F_3, F_4 and F_5–F_{10} generations, respectively. The development of resistance was studied by continuous exposure of adult males of each generation derived from nymphs that had not been exposed to selection, on deposits of 10 mg. malathion per sq. ft. in glass jars of 1 U.S. pint capacity. There was considerable variation in the time needed to give 50 or 90 per cent. kill or knockdown in both the selected and the normal colony, but the F_5–F_{10} generations of the former were found to be 4–11 times as resistant as the same generations of the latter.

Wright (J. W.) & Brown (A. W. A.). **Survey of possible Insecticide Resistance in Body Lice.**—*Bull. World Hlth Org.* **16** no. 1 pp. 9–31, 9 refs. Geneva, 1957. (With a Summary in French.)

The following is almost entirely based on the authors' summary. In 1953, the World Health Organization undertook a worldwide survey of resistance to DDT, BHC and pyrethrins in body lice (*Pediculus humanus humanus* L. (*P. h. corporis* Deg.)). Up to June 1956, 51 national health administrations had agreed to participate. The lice were exposed in the dark at 25°C. [77°F.] for 24 hours on a piece of cloth treated with 5·5 mg. insecticidal dust per sq. cm. The concentrations used were 0·1, 0·5, 1 and 5 per cent. technical DDT, 0·25 and 0·5 per cent. γ BHC and 0·02 and 0·04 per cent. pyrethrins; the pyrethrin dusts were prepared by diluting, with pyrophyllite, Type II MYL powder containing 0·2 per cent. pyrethrins, 2 per cent. sulfoxide [1,2-methylenedioxy-4-(2-(octylsulphinyl)propyl)benzene], 2 per cent. 2,4-dinitroanisole, 0·1 per cent. isopropyl cresols and 3 per cent. Celite

conditioner made up to 100 per cent. with pyrophyllite. Each concentration was tested with six samples of 10–20 lice in the countries concerned. There was evidence that 90 per cent. mortality after this exposure was representative of a normally susceptible field strain and 72 per cent. of the degree of resistance prevailing for some time at Cairo [*R.A.E.*, B **44** 29–30]. A mortality of 83 per cent. indicated a significant degree of resistance. Susceptibility in louse populations sometimes varied from one human host to another, so that generalisation from a few cases is not justified. Data from various regions of 37 countries are given in tables. Significant resistance to DDT was found to exist in many countries and, when the figures are considered as a whole, it was significantly higher in regularly dusted areas than in those never or occasionally dusted. In populations showing high survival rates, some individuals were resistant to all the concentrations tested. There was a slight correlation (0·42) between resistance to DDT and to BHC, but none between resistance to DDT and to pyrethrins.

Susceptibility to DDT was particularly feeble in the countries of the Middle East. Average mortality was less than 72 per cent. in some of the treated localities of Turkey, Syria and Jordan, and was as low as 33 per cent. in the Gaza Strip (Egypt), where dusting is still regularly carried out by relief workers in refugee camps. In Asia, no evidence of resistance was found in lice in India, Pakistan or Afghanistan, where dusting was practised to a varying degree, but higher resistance than that of the Cairo strain was found in every locality of Persia in which DDT has been used, whether regularly or occasionally. All the samples examined in Japan, where resistance was recorded as early as 1948 [*cf.* **43** 31], showed resistance. A Japanese strain reared in the laboratory under conditions of DDT-selection for ten generations developed a degree of resistance represented by an average mortality of 21 per cent. The lowest mortalities found in the survey were in two samples of lice from townships in South Africa, in both of which DDT had been used. Lice from Mexico City, which has regular dusting, were as susceptible as those from Guatemala City, which has no dusting. Some resistance was shown in towns in Peru in which dusting was regularly carried out, but none in one in which it was used only occasionally. DDT is used extensively in parts of Bolivia, and it has been noted that its effectiveness has gradually decreased, but no laboratory tests were made. There appeared to be no diminution in susceptibility to BHC or pyrethrins, with a few exceptions, notably in Japan, where the percentage mortality varied between 0 and 57 in tests with 0·5 per cent. γ BHC, exceeded 60 in only four of the 12 populations tested with 0·04 per cent. pyrethrins and was less than ten in two of them. BHC has been used extensively in Japan since 1952 and the occurrence of resistance to it in lice was reported in that year, but in four out of ten regions outside Japan in which resistance to BHC was high, this insecticide had never been used.

LINDQUIST (A. W.). **Effectiveness of Organo-phosphorus Insecticides against Houseflies and Mosquitos.**—*Bull. World Hlth Org.* **16** no. 1 pp. 33–39, 9 refs. Geneva, 1957. (With a Summary in French.)

Laboratory and field studies that are being carried out by the Entomology Research Branch of the Agricultural Research Service of the United States Department of Agriculture on the use of organophosphorus compounds for the control of house-flies [*Musca domestica* L.] and mosquitos are reviewed. Many of the results have been published elsewhere.

Malathion applied at 100 mg. per sq. ft. to plywood panels as a wettable-powder suspension or oil solution gave complete mortality in 24 hours of normal laboratory-bred house-flies exposed for two hours under petri dishes

when the deposits were fresh, 90–100 per cent. kill after two weeks and 75–80 per cent. after four weeks [*cf. R.A.E.*, B **47** 12]. An emulsion prepared from technical malathion and one made from a commercial concentrate, also at 100 mg. malathion per sq. ft., gave 34 and 75 per cent. kill, respectively. Laboratory tests confirmed findings by E. J. Hansens that diazinon [O,O-diethyl O-2-isopropyl-4-methyl-6-pyrimidinyl phosphorothioate] had enough vapour toxicity to impregnate plywood panels hanging 3 in. from a wall treated with 200 mg. per sq. ft. [*cf.* **45** 36]. Panels exposed for 5–7 days still killed flies several days after being removed. The addition of Aroclor 5460 (a chlorinated terphenyl) [*cf.* **44** 105, etc.] prolonged the effectiveness of DDVP (dimethyl 2,2-dichlorovinyl phosphate) against normal flies. Acetone solutions of the two substances, alone and in combination, were sprayed on unfinished and on varnished plywood panels at 25 mg. DDVP and 100 mg. Aroclor 5460 per sq. ft. DDVP alone gave complete kill with exposure for 30 minutes on deposits 1 and 7 days old, and for 60 minutes on deposits 14 and 28 days old. However, exposure for 30 minutes to the mixture of DDVP and Aroclor 5460 killed all flies when the deposit was 28 days old. The Aroclor alone was ineffective. There was no consistent difference between results on unfinished and varnished wood. In tests with the same deposits in barns, the mixture reduced fly populations by 76–99 per cent. for 16 days [*cf.* **47** 27, etc.], whereas DDVP alone was ineffective after 5–7 days. However, the mixture is difficult to prepare for practical use because of the stickiness of the Aroclor. Sprays containing Dipterex (Bayer L 13/59 [dimethyl 2,2,2-trichloro-1-hydroxyethylphosphonate]) applied at 100 and 200 mg. per sq. ft. in dairy barns gave control for only four days. A 50 per cent. water-soluble Dipterex powder applied around pig-pens gave control for 1–17 days.

Work on synergists for the organophosphorus compounds is reviewed from the literature [**42** 187; **43** 48, 118]. It is considered doubtful whether their use would be generally practicable because of their high cost, but they might have limited application in cases where resistance has become critical and no substitute materials are available or where it is desired to prevent the development of resistance in susceptible populations.

To investigate resistance to organophosphorus insecticides [*cf.* **47** 26], a laboratory colony was established from flies collected in dairy barns that had been treated repeatedly for 3–4 years with baits containing phosphorus insecticides. The adults were maintained on food containing 0·02 per cent. Dipterex, and about 90 per cent. mortality occurred in the first few days of each generation. When portions of the fifth, six and twelfth generations that had not received poisoned food were given poisoned baits, the fifth generation was highly resistant to Dipterex, and the sixth and twelfth generations were about 5–10 times as resistant as the normal colony to this insecticide and to malathion. The second laboratory generation of each of four colonies from dairy barns was found, when similarly tested, to be more resistant to both compounds than the normal flies. The least susceptible strain was about 5–20 times as resistant as the normal colony [*cf.* **47** 85]. T. L. Hopkins & W. Robbins exposed flies to a deposit of Dipterex on plywood and thereafter applied the insecticide topically to the adults in each generation bred from the 10–25 per cent. surviving. The F_4 generation was about four times as resistant as the parent stock but there was little change in the F_{10} and F_{14} generations.

Results are also reviewed, mainly from the literature, indicating that the organophosphorus insecticides are at present effective substitutes for DDT and other chlorinated-hydrocarbon insecticides [*cf.* **45** 4, 193] for use against larvae and adults of Culicine mosquitos that are resistant to the latter [*cf.* **46** 107]. Deposits do not retain their effectiveness so long as those of DDT, however, and probably will not be so effective against Anophelines.

Barnes (J. M.), Hayes (W. J.) & Kay (K.). **Control of Health Hazards likely to arise from the Use of Organo-phosphorus Insecticides in Vector Control.**—*Bull. World Hlth Org.* **16** no. 1 pp. 41–61, 15 refs. Geneva, 1957. (With a Summary in French.)

Organophosphorus insecticides are now used for the control of certain insects, particularly flies, that have become resistant to DDT and its analogues. They comprise some compounds, such as malathion, that are no more toxic for mammals than DDT, and others that are much more so. They act by inhibiting cholinesterase, some directly and others after their structure has been changed in the organism. The symptoms caused in man are described, and details are given of three cases of severe poisoning, of which one, in a worker who failed to take precautions when using parathion, was fatal. Determination of blood-cholinesterase levels is useful as a routine for estimating the risks run by exposed persons, or for confirming or refuting a diagnosis of poisoning and for following the process of recovery. Various methods of determining blood cholinesterase are described.

Brown (A. W. A.). **Methods employed for determining Insecticide Resistance in Mosquito Larvae.**—*Bull. World Hlth Org.* **16** no. 1 pp. 201–204, 8 refs. Geneva, 1957.

The various requisites of different methods for testing the resistance of mosquito larvae to insecticides [*cf. R.A.E.*, B **41** 41; **42** 124] are reviewed. It is concluded that the most important considerations when procedure is being chosen are simplicity and suitability for both Culicines and Anophelines, and it is considered inadvisable to try to adhere in all respects to any one pre-existing method for its own sake. It is desirable that the containers used, preferably enamel pans, should have an area of about 500 sq. cm. (77·5 sq. in.) and hold 1 litre (about $1\frac{3}{4}$ pints); that the water used should, if possible, be distilled water; that there should be 30 test larvae in the late third or early fourth instar, field collected or of the second laboratory-reared generation; that the insecticide should be the purified compound and the carrier ethanol (1:1,000 by volume); that the required final concentration should be obtained by dilution of standard solutions, that two replicate tests should be made at each of four insecticide concentrations; that the solutions should be stirred for 30 seconds with a glass rod; that larvae should be transferred by means of a wire-gauze spoon to 25 ml. (0·04 pint) water and this added to the test solution; that exposure to the insecticide should be for 24 hours, followed by transfer to clean water; and that mortality counts should be made both at the end of the test period and after a further 24 hours in clean water, the criterion of death being lack of movement on probing; the larvae that pupate should not be considered in the test.

Paulini (E.) & Reis (S. R.). **A Colorimetric Method for Estimation of DDT and BHC.**—*Bull. World Hlth Org.* **16** no. 1 pp. 208–211, 7 refs. Geneva, 1957.

A description is given of a simple field test by which DDT and BHC deposits on mud walls can be estimated and information thus provided on the extent to which the insecticide has covered the area treated and on the duration of its effectiveness. A sample of wall scrapings is taken from an area of 25 sq. cm. and mixed in a test-tube with 2·5 ml. benzene, the powder is allowed to settle or is precipitated by centrifuging, 0·5 ml. of the clear liquid is transferred to a clean test-tube and 5 ml. alcoholic solution of sodium hydroxide (prepared daily by mixing 1 ml. 20 per cent. sodium

hydroxide with 50 ml. ethanol) is added and mixed. After the mixture has stood for 20 minutes, 1 ml. 10 per cent. nitric acid and 1 ml. 1 per cent. ferric ammonium sulphate solution are added and mixed, and finally 1 ml. 0·2 per cent. alcoholic solution of mercuric thiocyanate. The colour developed is compared with standards prepared by taking three test-tubes each containing 0·5 ml. benzene, 5 ml. alcoholic sodium hydroxide, 1 ml. 10 per cent. nitric acid, 1 ml. of the ferric sulphate solution and 1 ml. of the mercuric thiocyanate solution and mixing in 2, 6 or 16 drops (0·1, 0·3 or 0·8 ml.) 0·005 N hydrochloric acid. The three standards have values corresponding to 0·3, 0·9 and 2·5 g. DDT per sq. metre, respectively.

Mohr (C. O.) & Smith (W. W.). **Eradication of Murine Typhus Fever in a rural Area. Preliminary Report.**—*Bull. World Hlth Org.* **16** no. 2 pp. 255–266, 1 graph, 20 refs. Geneva, 1957. (With a Summary in French.)

An account is given of an apparently successful attempt to eradicate murine typhus, of which *Xenopsylla cheopis* (Roths.) is regarded as the most important vector [*cf. R.A.E.*, B **47** 124, etc.], from a rural area of 130 sq. miles in two contiguous counties of south-western Georgia in which control had been attempted before [*cf.* **40** 166–167, etc.]; the attempt was made between July 1953 and May 1954 by poisoning commensal rats (*Rattus norvegicus* and *R. rattus*) and dusting rat runs, burrows, etc. with 10 per cent. DDT to control *Xenopsylla cheopis*. It was estimated that half the 713 agricultural premises of the area harboured rats immediately before the campaign. Complement-fixing typhus antibodies were found in 44 per cent. of 87 rats tested. During the campaign, rats were eliminated from 88 per cent. of the infested premises and flea populations were considerably reduced. About 4 lb. DDT dust was used on each of the premises. None of the 58 individuals of *R. norvegicus* or 81 of *R. rattus* examined between 9th February and 8th June 1955 was infested with *X. cheopis*, whereas about eight of these fleas were found per infested rat on nearly a third of some 60 individuals of *R. norvegicus* trapped from an untreated area between 9th June and 14th October. Rats returned to a quarter of the cleared premises within 10–18 months, but murine typhus had been practically eradicated, as the rate of infestation by rats and fleas was not high enough to maintain it. In the 1955 survey the only commensal rat, out of 124 tested, that showed typhus antibodies, may have been an immigrant from an untreated area. It is concluded that the eradication of murine typhus is practicable in areas resembling the one in which this test was made, and that plague in commensal rats could probably be eliminated in the same way.

de Zulueta (J.), Jolivet (P.), Thymakis (K.) & Caprari (P.). **Seasonal Variations in Susceptibility to DDT of *Anopheles maculipennis* in Iran.** —*Bull. World Hlth Org.* **16** no. 2 pp. 475–479, 3 refs. Geneva, 1957.

The susceptibility of females of *Anopheles maculipennis* Mg. (represented by several forms) to deposits of DDT on filter paper at different seasons was examined in 1956 by Busvine & Nash's method [*R.A.E.*, B **41** 156] in localities in Persia in which chlorinated-hydrocarbon insecticides had not been used. In two districts of Isfahan, the LC50's were 1·8 and 2·3 per cent. on 22nd–25th September, when most females were still in full ovarian activity and exposure temperatures were between 71·5 and 76°F., and 6 and 6·7 per cent., respectively, on 15th–16th October when nearly all the females were entering hibernation and developing fat-body, and exposure temperatures were 66 or 67°F. The differences between the results at the two seasons are

statistically significant. At a village in the Caspian region, the LC50 averaged 0·9 per cent. on 31st July and 5th August when the temperatures during exposure were 81·5 and 82°F., and was 16·4 per cent. on 22nd October with an exposure temperature of 66°F. The greater difference is attributed to the longer time that had elapsed between the two surveys. It is not, however, statistically significant. The increased tolerance may have been a result of the development of fat-body. The differences in temperature are considered too small to have been responsible.

Fox (R. M.). *Anopheles gambiae* **in Relation to Malaria and Filariasis in coastal Liberia.**—*Amer. J. trop. Med. Hyg.* **6** no. 4 pp. 598–620, 8 figs., 22 refs. Baltimore, Md., 1957.

Between 1st June 1955 and 24th July 1956, adults of *Anopheles gambiae* Giles were collected in 16 villages and a camp in Marshall Territory in coastal Liberia, by three techniques: hand-catching on human bait in the open and trapping with human bait, both at night, and hand-catching of resting mosquitos in native houses in the morning. A deliberate attempt was made to exclude *A. g. melas* Theo., which the author treats as a distinct species, by making the bulk of the collections from localities from which the latter had been shown, by identification of the eggs, to be absent. The samples obtained by all three methods were of equal value for the estimation of population size and for the study of rates of infectivity in respect of both malaria and filariasis, but the greatest numbers of mosquitos were taken in the open, where *A. gambiae* fed readily. Catches were greatest during the rainy season [*cf. R.A.E.*, B **44** 198; **45** 130], reaching their highest peaks near its beginning (May) and end (September), and the population of *A. gambiae* varied inversely with the temperature, which is lowest during the rains.

The oocyst rate (studied from July 1955 to July 1956) and the sporozoite and total infection rates (studied from January to July 1956) were found to yield the same epidemiological pattern, the last being the most accurate and the easiest to interpret. Malaria was transmitted throughout the year with slight peaks in the oocyst rate from the beginning of October to late November, in the middle of the dry season in February and at the beginning of the rainy season from the middle of May to late in July. When the mosquito population was taken into consideration, however, there were only two main periods of transmission, one from May to July and a secondary one from September to November. The relationship between the sporozoite rate and the oocyst rate showed that the average age of the mosquitos studied was 27 days. The species of *Plasmodium* present could be identified in a third of the positive midguts. *P. falciparum* made up 82·4 per cent. of them and *P. malariae* and *P. ovale* each 8·8 per cent. *P. vivax* was not found.

The over-all rate of infection with third-stage filarial larvae, assumed to be *Wuchereria bancrofti*, in females of *A. gambiae* dissected between October 1955 and July 1956 was 3·6 per cent. [*cf.* **45** 129–130, etc.]. Although this figure includes some mosquitos collected from an area where *A. g. melas* occurs during the dry seasons, the collections were made in the rainy period when this form is absent or is so rare that it is believed that it did not enter significantly into the picture. Of the infections, 6 per cent. were in the abdomen alone, and the remainder in the thorax and proboscis. The period of greatest transmission appeared, on the basis of percentage of mosquitos positive and number of filariae per positive mosquito, to be May–July. Rates of infection were highest near the tidal rivers and became progressively lower inland away from these rivers and on higher ground.

de Rodaniche (E.), Galindo (P.) & Johnson (C. M.). **Isolation of Yellow Fever Virus from** *Haemagogus lucifer, H. equinus, H. spegazzinii falco, Sabethes chloropterus* **and** *Anopheles neivai* **captured in Panama in the Fall of 1956.**—*Amer. J. trop. Med. Hyg.* **6** no. 4 pp. 681–685, 7 refs. Baltimore, Md., 1957.

Between 22nd August and 20th December 1956, 7,094 mosquitos belonging to 15 species or groups of species were collected near Mandinga on the Atlantic coast of eastern Panama and examined for yellow-fever virus. The species that were most plentiful were *Aëdes leucocelaenus clarki* Carpenter & Trapido, *Sabethes chloropterus* (Humb.), *Haemagogus regalis* D. & K. (*lucifer* (H., D. & K.)) and *H. spegazzinii falco* Kumm, Osorno & Boshell, and the numbers taken were 1,707, 1,409, 1,162 and 853, respectively. The virus was isolated once by intracerebral injection into mice and subcutaneous injection into monkey from *H. regalis*.

The occurrence of a fatal human case of yellow fever led to the installation of a mosquito collecting station in the locality in which the infection had originated, which was in the Cerro Azul area on the Pacific side of the Continental Divide some 40 miles east of the Canal Zone. From 13th September to 8th October, 1,419 mosquitos of eight species or species groups were collected and the virus was isolated twice each from *H. regalis* and *S. chloropterus* and once each from *H. spegazzinii falco, H. equinus* Theo. and *Anopheles neivai* H., D. & K. The numbers of these species taken were 649, 265, 56, 48 and 49, respectively. All this batch of isolations was made by intracerebral injection into mice. These results include the first recorded recoveries of yellow-fever virus from pure pools of *H. regalis* [*cf. R.A.E.*, B **33** 112] and from any species of *Anopheles*. The period of greatest abundance of *H. regalis* in eastern Panama [*cf.* **46** 114] appears to bear a direct relationship to the appearance of yellow fever there, and this species would seem to be an important vector.

Anderson (C. R.), Aitken (T. H. G.), Downs (W. G.) & Spence (L.). **The Isolation of St. Louis Virus from Trinidad Mosquitoes.**—*Amer. J. trop. Med. Hyg.* **6** no. 4 pp. 688–692, 4 refs. Baltimore, Md., 1957.

Antibodies neutralising the virus of St. Louis encephalitis were found in 15 of 348 sera of Trinidad residents examined in an island-wide survey in 1953–54. During an intensive search for viruses, begun in April 1955, suspensions of over 160,000 arthropods, mainly mosquitos, were inoculated into infant mice, and three strains of St. Louis virus were isolated, one each from *Culex coronator* D. & K., *C. caudelli* D. & K. and *Psorophora ferox* (Humb.); the mosquitos had been collected in September biting man in forested areas. These are the first known isolations of St. Louis virus outside the continental United States.

Stark (H. E.) & Kartman (L.). **Studies on** *Pasteurella pestis* **in Fleas. VI. The Laboratory Culture of** *Xenopsylla vexabilis hawaiiensis* **Jordan, 1932.**—*Amer. J. trop. Med. Hyg.* **6** no. 4 pp. 707–711, 7 refs. Baltimore, Md., 1957.

The following is largely based on the authors' summary of this sixth paper of a series [*cf. R.A.E.*, B **47** 58]. Large numbers of the Hawaiian flea, *Xenopsylla vexabilis hawaiiensis* Jordan, a rural species most prevalent on field rodents [*cf.* **23** 157], were reared for plague transmission experiments [**46** 162–163] on caged host rats (albino *Rattus norvegicus*) kept in white enamelled buckets, together with a larval substrate of autoclaved sand and powdered dog pellets. A layer of wood shavings on copper screening over

the substrate absorbed the rat's urine. Cultures were kept at a temperature of 23–27°C. [73·4–80·6°F.] and a relative humidity of 93–100 per cent. Similar units had already been used for rearing *X. chopis* (Roths.), but this species required lower temperature and humidity. The pupae were sifted from the sand about every three weeks for maximum production. A host was left in the breeding unit for the first seven days after each sifting, and then removed to another unit, so that the original one remained without a host for the next 14 days.

In nature, *X. v. hawaiiensis* was found to breed in rats' nests, which consisted mainly of dried grass. This evidence, together with the results of laboratory culture, suggests that the fleas probably do not breed on the surface of the ground, nor do the larvae need green grass, as formerly believed [**23** 157]. The grass probably acted beneficially by raising humidity.

Miles (V. I.), Kinney (A. R.) & Stark (H. E.). **Flea-Host Relationships of associated *Rattus* and native wild Rodents in the San Francisco Bay Area of California, with special Reference to Plague.**—*Amer. J. trop. Med. Hyg.* **6** no. 4 pp. 752–760, 28 refs. Baltimore, Md., 1957.

An important aspect of the epidemiology of plague is the route by which infection travels from the primary reservoir (wild rodents) to man. Domestic rats (*Rattus* spp.) are important potential hosts, particularly in the western United States, where there is a vast natural reservoir of enzootic plague in wild rodents. The rats seldom live independently of man or his influence, and man has provided many habitats for them adjacent to those of wild rodents. As transfers of plague are probably achieved between wild and domestic rodents through the interchange of infected fleas [*cf. R.A.E.*, B **40** 19–20], the extent to which these rodents mingle and the incidence of fleas typical of one group on members of the other was examined quantitatively between 31st March 1953 and 16th April 1954 in 15 localities in the region of San Francisco Bay, in which the two groups of rodents appeared to be living in close association. The dead rodents were put into flea-proof bags on removal from snap traps. Rodents of both groups were taken at only eight of the localities, and in these trapping was repeated at about 3-month intervals three or four times. Rats were caught in appreciable numbers in only four localities near two pig farms, a grain elevator and a refuse dump. Meadow mice (*Microtus californicus*) were found in the wild-type habitats of all areas and were commonly associated with commensal rats. The host relationships of 5,069 fleas of 15 species and 1,761 mammals comprising four species of wild rodents, a shrew, *Rattus norvegicus* and house mice (*Mus musculus*), are shown in a table, in which the number of fleas, the number per host examined and the percentage occurrence are shown for each species of flea on each species of host. The percentage occurrence represents the proportion of fleas that would infest the host if equal numbers of each host had uniform opportunity to become infested with the species of flea in question. It is obtained by dividing the number of fleas of the given species per host examined by the total number of that species on all hosts and multiplying by 100.

Much the most plentiful flea was *Malaraeus telchinum* (Roths.), of which 2,527 individuals were taken, 2,349 of them on meadow mice, 56 on rats, 11 on house mice and the remainder on wild mammals. Of 401 individuals of *Nosopsyllus fasciatus* (Bosc), 283 were on rats, 9 on house mice and the remainder on wild mammals. In areas in which rats comprised at least 25 per cent. of the total rodent capture and comparatively large numbers of rats and meadow mice were taken together, *N. fasciatus* was found on 18·5 per cent. of the latter and *M. telchinum* on 5·8 per cent. of the former, but

where rats formed less than 10 per cent. of the total rodents caught, *M. telchinum* was found on 24 per cent. of them. *N. fasciatus*, *M. telchinum* and *Catallagia wymani* (Fox), a wild-rodent flea, occurred on all the principal species of mammals taken, and percentage occurrences suggested that all three may be frequently exchanged between *R. norvegicus* and wild rodents. *Hystrichopsylla* sp., *Atyphloceras multidentatus* (Fox), and *Monopsyllus wagneri ophidius* (Jordan) occurred on both meadow mice and white-footed mice (*Peromyscus maniculatus*) but not on rats. *Hystrichopsylla* has been shown to be an efficient laboratory vector. Species that appeared from the percentage occurrence to be highly host specific were *Opisodasys keeni nesiotus* Augustson on white-footed mice, *X. cheopis* (Roths.) on rats and *Diamanus montanus* (Baker) and *Hoplopsyllus anomalus* (Baker) on California ground squirrels (*Citellus beecheyi*); *Leptopsylla segnis* (Schönh.) was almost confined to rats and house mice, the percentage occurrence being four times as great on the former as on the latter. The other four species were taken in negligible numbers. Interchanges of fleas involving ground squirrels were very infrequent. Plague bacilli were isolated from four pools of fleas of mixed species from wild rodents or their nests in one area.

These results, together with the known vector ability, suggest that *N. fasciatus*, *Hystrichopsylla* sp. and *M. telchinum* may be of particular concern; the first two have been shown to be at least fairly efficient plague vectors [*cf.* **26** 87; **47** 58] and though individuals of the last are poor transmitters in the laboratory, positive results have been obtained with large numbers.

Burgdorfer (W.). **Artificial Feeding of Ixodid Ticks for Studies on the Transmission of Disease Agents.**—*J. infect. Dis.* **100** pp. 212–214, 2 figs., 5 refs. Chicago, Ill., 1957.

The following is partly based on the author's summary. A technique for the artificial feeding of Ixodid ticks for studies on the transmission of pathogens is described. Glass capillary tubes filled with infective fluid are put over the hypostome and chelicerae of ticks immobilised and held in position with plasticine on a microscope slide. The ticks ingest up to 0·03 ml. fluid during a feeding period of 4–6 hours at room temperature. The technique proved suitable for the experimental infection of adults of *Dermacentor andersoni* Stiles and *Amblyomma maculatum* Koch with *Leptospira pomona* [*cf. R.A.E.*, B **46** 181] and of those of *D. andersoni* with rabies virus, after attempts to make the ticks feed through membranes had failed. It is economical and provides ticks uniformly infected with a suspension of known concentration, with which transmission experiments can be carried out by putting them, after a brief incubation period, on laboratory animals to complete engorgement.

Papers noticed by Title only.

de Rodaniche (E.) & Galindo (P.). **Isolation of Ilhéus Virus from *Sabethes chloropterus* [(Humb.)] captured in Guatemala in 1956.**—*Amer. J. trop. Med. Hyg.* **6** no. 4 pp. 686–687, 2 refs. Baltimore, Md., 1957.

Vargas (L.) & Díaz Nájera (A.). **Simúlidos mexicanos.** [List of Mexican Simuliids, with Keys (including new Species).]—*Rev. Inst. Salubr. Enferm. trop.* **17** no. 4 pp. 141–399, 528 figs., 9 refs. Mexico, D. F., 1957.

Arora (G. L.) & Chopra (N. P.). **Some Observations on the Biology of *Lipeurus tropicalis* Peters (Mallophaga: Ischnocera).**—*Res. Bull. Panjab Univ.* (Zool.) no. 130 pp. 485–491, 1 pl., 6 refs. Hoshiarpur, 1957.

The following is based almost entirely on the authors' summary. *Lipeurus tropicalis* Peters, the bird louse that infests the domestic fowl in Hoshiarpur, Punjab (India), is a permanent ectoparasite living in the basal covered parts of the feathers on the head and neck and in the wing coverts. It feeds on fragments of feathers, skin pellicle, sheaths of growing feathers and the coagulated blood on or around wounds or injuries. It dies when the host dies or if transferred to the body of an unrelated kind of bird. It is more numerous on the host in the summer (March to September) than in the winter (October to February). Migration from one host to another takes place as a result of direct contact of hosts during copulation or brooding or when birds are locked up together. Mating in *L. tropicalis* starts 2–4 hours after emergence. The first egg is laid 2–3 days after mating, when the female deposits it at the base of the barb, fixing it there by a sticky fluid exuded from the genital opening. As many as 3–5 eggs are laid in a day. The optimum temperature for oviposition and subsequent development is 35°C. [95°F.] at a relative humidity of 80–85 per cent. Under these conditions the average duration of adult life is 12 days in the male and 15 days in the female, and the average number of eggs laid per female is 23. A rise in temperature to 39°C. [102·2°F.] decreased the length of life and the average numbers of eggs laid, but increased the daily oviposition rate, whereas a fall to 32°C. [89·6°F.] decreased all three.

Graham (N. P. H.). **Control of Fly Strike. The Use of light Surface Sprays as a Means of controlling Body Strike.**—*Aust. vet. J.* **33** no. 6 pp. 137–140, 3 refs. Sydney, 1957.

The following is largely based on the author's summary. The fact that some insecticides will diffuse down the wool fibre [*R.A.E.*, B **44** 89] suggested that it might be possible to protect sheep against body strike by blowflies by applying the insecticide as a light surface spray instead of by jetting to saturate the wool [**47** 129, etc.]. In a large-scale field trial, carried out with Merino sheep in New South Wales in 1955–56, the effects of light surface applications of dieldrin and aldrin in emulsions and saturation of the fleece on the back with dieldrin were compared. In both treatments, the spray fluid was applied to a band about 5–6 in. wide running down the back from the crown of the head to the rump. Some 2–3 months elapsed between the time of treatment and the onset of blowfly activity. The results indicated that surface spraying was effective provided that a sufficiently high concentration was used. Under the conditions of the trial, in which the wool was only $\frac{1}{2}$ or $\frac{3}{4}$ in. long, surface spraying with dieldrin at 0·2–0·5 per cent. gave results equivalent to those given by jetting with 0·02 per cent. In spite of the smaller volume of emulsion applied in the surface spraying (about 1 gal. for 25 sheep as against 1 gal. for five sheep), 2–4 times as much insecticide had to be applied to give results equal to those obtained by jetting. Treatment could, however, be carried out much more quickly. Aldrin gave results inferior to dieldrin, 0·5 per cent. aldrin being only slightly better than 0·1 and inferior to 0·2 per cent. dieldrin [*cf.* **46** 55].

Balarama Menon (P.). **The Incidence of Surra and Tabanid Flies in Rajasthan.**—*Indian J. vet. Sci.* **27** pt. 1 pp. 1–16, 1 graph, 3 maps, 7 refs. New Delhi, 1957.

Rajasthan is a generally dry region of north-western India and an important camel-rearing area. Most of the camels are in the west and south-west,

which are the driest parts, but some are found throughout the State and in Ajmer, which Rajasthan completely surrounds. The occurrence of surra (*Trypanosoma evansi*) and Tabanids (which are known to transmit it) in the two States was studied for the first time in March 1954, in the dry season. In camels, the disease is chronic and can last for three years before death results. Its incidence was high, an average of about 6,000 cases being treated every year in veterinary dispensaries alone, and increased sharply in August and September, after the monsoon, to reach a peak in October or November; it fell to a minimum in April, May and June, when the water sources are dry. The disease is commonest in the wetter regions of the south-east, which have good grazing and large numbers of reservoirs, lakes and canals that provide breeding places for Tabanids However, it is not uncommon in the dry areas, since camels from these parts come in contact with diseased ones when taken for foraging and become infected. Cases of the disease are reported from Ajmer, but most are believed to be in introduced camels.

The survey showed that Tabanids were present in all the Divisions of Rajasthan and in Ajmer and could complete their life-cycle under the conditions prevailing there, even in Bikaner, where the average annual rainfall is only 7–8 in. All stages were found, and three species of *Tabanus* (*T. rubidus* Wied., which is a well-known vector, *T. striatus* F. [*cf. R.A.E.*, B **43** 181, etc.] and *T. macer* (Big.) [**15** 44]) and an undetermined species of *Atylotus* were recorded. It is assumed that a wider survey in the post-monsoon months would reveal the presence of other species. Tabanid eggs (probably *Atylotus*), collected from a reservoir in Jaipur, were found to be parasitised by an Encyrtid, *Centrodora* sp., which has apparently not previously been recorded from Tabanids in India.

Jettmar (H. M.). **Über die Rolle der Zecken bei der Verbreitung der zweiwelligen Virus-Meningoencephalitis in Österreich.** [On the Rôle of Ticks in the Spread of two-peak Virus Meningo-encephalitis in Austria.]—*Anz. Schädlingsk.* **30** pt. 9 pp. 129–132, 29 refs. Berlin, 1957.

A form of virus meningo-encephalitis similar to, but less virulent than, Russian spring-summer encephalitis occurs in certain wooded areas of Austria, where it is apparently transmitted by *Ixodes ricinus* (L.). It also occurs in Yugoslavia [*cf. R.A.E.*, B **46** 186] and Czechoslovakia [*cf.* also **46** 119]. In investigations in Austria, no infection was found in mosquitos from infected districts, but four strains of the virus were isolated in 1954–55 from batches of *I. ricinus* taken on wild and domestic animals in various parts of Upper and East Styria, where cases of the disease are frequent, one from the head of a tick found in the skin of a patient in East Styria and one from ticks taken on a dog in a district near Vienna from which the disease has so far not been reported. All the strains reacted similarly to one from man in serological and transmission tests. Ticks from the Tirol were not infected. *I. persulcatus* Schulze, the vector of Russian spring-summer encephalitis, transmits the causal virus to its progeny [*cf.* **29** 42], and similar transmission by *I. ricinus* would account for the fact that this species is an effective reservoir. The type of environment preferred by *I. ricinus* [*cf.* **42** 177], the habits of the adults [*cf.* **31** 70] and methods adopted in the Soviet Union to protect the population of forest areas from ticks are reviewed, and methods of public and private protection against the Austrian virus are suggested. The latter include the removal of low vegetation from inhabited localities, the driving of cattle through infested places and subsequent collection of ticks from them, spraying domestic animals

with 10 per cent. DDT, and the building of barriers of grass and foliage around dwellings and the regular spraying of them with repellents so long as adult ticks are present.

KITAOKA (S.) & YAJIMA (A.). **Effects of Insecticides on Ticks. II. Effect on Loss of Body Weight and Oviposition of Ticks.** [*In Japanese.*]—*Jap. J. appl. Ent. Zool.* **2** no. 1 pp. 11–16, 4 figs., 25 refs. Tokyo, 1958. (With a Summary in English.)

The experiments described in this second paper of a series [*cf. R.A.E.*, B **47** 149] were concerned with the effects of sublethal doses of toxicants applied topically to engorged females of *Boophilus microplus* (Can.) (*caudatus* (Neum.)). They were carried out at a temperature of 27·5°C. [81·5°F.] and a relative humidity of 100 per cent. For γ BHC, the percentage loss of body weight increased abruptly as the dosage rose above 6 μg. per g. and reached a maximum at about 100 μg., thereafter falling again. Parathion, allethrin and TEPP [tetraethyl pyrophosphate] showed a similar tendency, the critical doses being 6, 100 and 135 μg. and the maxima about 100, 300 and 1,000 μg. per g., respectively, but no loss of weight followed treatment with α BHC at 2·82–35·6 mg., p,p′DDT at 10–1,110 μg. or o,p′DDT at 100–3,000 μg. per g. The loss of weight increased with the severity of the toxic symptoms produced, and it presumably resulted from the elimination or secretion of water, this varying with the activity of the epidermal cells. Oviposition was inhibited by treatment with γ BHC, parathion, allethrin and p,p′DDT, and reduced by α BHC and o,p′DDT at 3 mg. per g.

DRUMMOND (R. O.). **Laboratory Screening Tests of Animal Systemic Insecticides.**—*J. econ. Ent.* **51** no. 4 pp. 425–427, 14 refs. Menasha, Wis., 1958.

Many new insecticides were examined for systemic properties at Kerrville, Texas, in short-term laboratory tests in which they were administered orally or by subcutaneous injection to guineapigs infested with nymphs of *Amblyomma americanum* (L.) and young larvae of *Callitroga hominivorax* (Coq.) [*cf. R.A.E.*, B **45** 40]; adults of *Stomoxys calcitrans* (L.) were subsequently allowed to feed on the guineapigs. The insecticides were generally used as 5 per cent. solutions in Tween-20 (polyoxyethylene sorbitan monolaurate), initially at 100 mg. per kg. body weight; if this dosage was lethal to the guineapig or killed any of the arthropods, the test was repeated with successively lower doses until there was no insecticidal activity or no lethal effect on the guineapig. Results of tests with nine compounds are given to illustrate variations in toxicity to the arthropods and lethality to the guineapigs. Am. Cyanamid 12,880 (O,O-dimethyl S-(methylcarbamoyl)methyl phosphorodithioate [dimethoate]), Bayer 23,453 (O,O-dimethyl S-2-(ethylsulphinyl)ethyl phosphorodithioate) and Bayer 23,129 (O,O-dimethyl S-2-(ethylthio)ethyl phosphorodithioate) gave complete kill of all three arthropods, when administered orally, at dosages varying from 5 to 25 mg. per kg., with no guineapig mortality; when injected subcutaneously, the first two compounds gave the same results at dosages varying from 5 to 50 mg. per kg., but the third did not kill any of the arthropods at the highest dosages used that were not lethal to the guineapigs, which were killed at 50 mg. per kg. Bayer 21/199 [O,O-diethyl O-3-chloro-4-methyl-7-coumarinyl phosphorothioate] and Dow ET-57 [purified O,O-dimethyl O-2,4,5-trichlorophenyl phosphorothioate] gave complete kill of the insects at dosages varying between 25 and 75 mg. per kg., and there were no deaths in the guineapigs at these dosages except when Bayer 21/199 was given orally; these two compounds did not kill any ticks at the highest dosage used that was not

lethal to the guineapigs. Hercules AC-528 [2,3-p-dioxane S,S-bis(O,O-diethyl phosphorodithioate], Tedion [2,4,5,4′-tetrachlorodiphenyl sulphone], Thiodan [6,7,8,9,10,10-hexachloro-1,5,5a,6,9,9a-hexahydro-6,9-methano-2,4,3-benzodioxathiepin-3-oxide] and Trithion [O,O-diethyl S-p-chlorophenylthiomethyl phosphorodithioate] were ineffective at the highest dosage used that was not lethal to the hosts. Compounds that showed promise in tests with guineapigs were evaluated further in sheep and goats, being administered as drenches to sheep infested with *C. hominivorax* and to goats infested with *C. hominivorax* and nymphs and adults of *A. americanum*. After treatment, adults of *S. calcitrans* were fed on the goats. Dimethoate, Bayer 23,129 and ET-57 killed *C. hominivorax* in these tests at 25, 10 and 100 mg. per kg., respectively, and only the first compound was also effective against the other ectoparasites and not lethal to the hosts. Bayer 23,129 killed the hosts at 25 mg. per kg., but ET-57 was not lethal to them.

Hewitt (R.) & others. **Carbamoyl Alkyl Phosphorodithioates as Chemotherapeutic Agents: Effects of Dimethoate against Grubs in Cattle.**—*J. econ. Ent.* **51** no. 4 pp. 445–450, 12 refs. Menasha, Wis., 1958.

As a result of preliminary tests of carbamoyl alkyl phosphorodithioates [*R.A.E.*, B **47** 100], Am. Cyanamid 12,880 or dimethoate (O,O-dimethyl S-(methylcarbamoyl)methyl phosphorodithioate) was chosen for trials against *Hypoderma lineatum* (Vill.) and *H. bovis* (Deg.) in cattle under laboratory conditions. In tests with 21 calves on the effect of dimethoate administered internally against second- and third-instar larvae, single oral doses of 2·5–40 mg. per kg. body weight killed 86–100 per cent. of second-instar larvae in the backs within about one week of treatment; the lowest dose tested against *H. bovis* was 5 mg. per kg., and the lowest dose to give uniformly good results against third-instar larvae of either species, whether administered orally or intramuscularly, was 10 mg. per kg. Single oral or intramuscular doses of 10 or 20 mg. per kg. killed at least half of the first-instar larvae of *H. lineatum* in the gullets of five out of seven calves slaughtered 14–25 days after treatment. A similar effect was obtained in one calf treated with 5 mg. per kg. orally and sacrificed 25 days later, but not in two treated with 5 mg. per kg. intramuscularly and sacrificed after 28 and 37 days. In calves weighing 118–427 kg., single oral doses of 40 mg. dimethoate per kg. and above, produced severe toxic symptoms, and 80 or 100 mg. was lethal in two days or less; 15 and 20 mg. produced mild toxic symptoms, and doses lower than 15 mg. per kg. generally no symptoms at all. Toxicity in sheep (mostly lambs weighing 25–71 kg.) was essentially similar. No differences were observed between the toxicity of samples of 99 per cent. and 94 per cent. purity, and two different drench formulations gave similar results. The effectiveness of dimethoate is compared with that of compounds of other types that are active chemotherapeutically against *Hypoderma* larvae [**43** 104, 187; **46** 88, 89, 139, 165]. Dimethoate appears to be more effective against the larvae in the backs of the cattle at the time of treatment than any of the other compounds administered orally, with the possible exception of diazinon. Its margin of safety is greater by the oral route than is that of aldrin or dieldrin, and resembles that of Dow ET-57 [purified O,O-dimethyl O-2,4,5-trichlorophenyl phosphorothioate].

Fay (R. W.), Kilpatrick (J. W.) & Morris III (G. C.). **Malathion Resistance Studies on the House Fly.**—*J. econ. Ent.* **51** no. 4 pp. 452–453, 1 ref. Menasha, Wis., 1958.

Strains of the house-fly (*Musca domestica* L.) from dairies at Phoenix, Arizona, and Bethesda near Savannah, Georgia, two places where malathion

deposits and poison baits were failing to give control [*cf. R.A.E.*, B **47** 26], were tested for resistance in the laboratory during the autumn of 1956. In initial tests, flies were exposed to plywood panels bearing deposits of 200 mg. malathion and 500 mg. sugar per sq. ft. from an emulsion spray. Percentage mortalities in 24 hours for females and (in brackets) males of a standard insectary strain and the Phoenix and Bethesda strains exposed for 30 minutes were 62 (94), 38 (78) and 6 (13). Corresponding figures for deposits of 200 mg. DDT per sq. ft. from an emulsion spray were 96 (99), 55 (64) and 2 (3).

In further studies, three still more resistant strains, B-5, B-25 and B-45, were obtained by selection from colonies of the Bethesda strain exposed in cages in which 5, 25 or 45 per cent. of the available resting surface had been sprayed to give deposits of 200 mg. malathion and 500 mg. sugar per sq. ft. For 3-day-old females of the standard strain, the Bethesda field strain and the F_4 generations of the B-5, -25 and -45 strains, the LD50's and (in brackets) LD90's in μg. malathion per fly, applied topically in acetone, were 0·48 (0·56), 1·17 (4·4), 1·5 (4), 5 (16) and 6·6 (24). When 200 3-day-old females of the standard, Bethesda field and B-5, -25 and -45 strains were kept for one hour in wire-screen cages measuring 18 × 16 × 14 in. and containing 2 per cent. dry malathion bait in a dish 2 in. in diameter, the average numbers on the bait (calculated from 10-minute counts) and (in brackets) the percentage mortalities after one hour were 5 (59), 2 (21), 4 (32), 0·8 (3) and 0·5 (0). There was little difference in the attractiveness of a 1 per cent. dry bait of Dipterex [dimethyl 2,2,2-trichloro-1-hydroxyethyl-phosphonate] for the various strains or its effectiveness against them, the corresponding figures being 18 (66), 14 (48), 19 (86), 19 (53) and 19 (81).

In April–May 1957, flies were collected again from the Bethesda dairy and, with flies from the standard and the B-45 strains, were exposed to malathion and sugar deposits of the same magnitude as in the previous autumn; the Bethesda field strain showed some loss of resistance, but the B-45 strain showed a greater homogeneity of resistance, with considerable reduction of the more susceptible portion of the strain. Topical application of malathion in acetone to 1-, 3- and 5-day-old flies of the F_{14} generation of the B-45 strain showed the LD50's and (in brackets) LD90's to be 18 (38), 9·2 (20) and 5·5 (11), respectively, for the females and 9 (15), 3·5 (6) and 1·8 (3) for the males.

MULLA (M. S.). **Control of Mites in Laboratory Cultures of the Eye Gnat, *Hippelates collusor* (Townsend).**—*J. econ. Ent.* **51** no. 4 pp. 461–462, 1 fig., 5 refs. Menasha, Wis., 1958.

Infestation by two species of mites, one belonging to the genus *Anoctus* and the other a Pyemotid, interfered with the rearing of the eye gnat (*Hippelates collusor* (Tns.)) in a laboratory colony in California. Adults and immature stages of *Anoctus* live in the breeding medium, and eggs are laid and adults feed in it, but the deutonymphs or hypopi attach themselves to emerging adults of *Hippelates* for purposes of dispersal. The immature stages of the other species develop in the medium, and the adults attach themselves to the sutural and membranous areas of the adults of *Hippelates*. The relationship in this case may be parasitic. Gnats infested with either mite are unfit for toxicological and biological studies or breeding. Surface treatment of the medium, as the gnats were beginning to emerge, with 50 ml. of an emulsion containing 1 per cent. DMC (Dimite [di(p-chlorophenyl)-methyl-carbinol]) [*cf. R.A.E.*, B **47** 13] gave satisfactory but not complete control, and two or three well timed applications were sometimes needed to provide large numbers of gnats relatively free of mites.

A study was therefore undertaken to evaluate the effectiveness of various acaricides mixed in the larval medium. Wettable-powder formulations of DMC, sulphur, ovex [p-chlorophenyl p-chlorobenzenesulphonate], Hercules AC-528 [2,3-p-dioxane S,S-bis(O,O-diethyl phosphorodithioate)], chlorobenzilate [ethyl 4,4′-dichlorobenzilate], Kelthane [di(p-chlorophenyl)-trichloromethyl-carbinol] and Tedion [2,4,5,4′-tetrachlorodiphenyl sulphone] were diluted with bentonite to make 1 or 0·1 per cent. dusts, and a dust containing 0·016 per cent. Aramite [2-chloroethyl 2-(p-tert.-butylphenoxy)-1-methylethyl sulphite] and 0·15 per cent. sulphur was also prepared. Dusts were mixed with dry larval medium at 50 or 100 g. per 6·5 lb. (enough for one cage) and 2 U.S. gal. water was added. The only acaricide tested that controlled the mites without harming the gnats was Tedion, and it was routinely used at 50 g. 0·1 per cent. dust per cage to eliminate the mites from the colony, and is now incorporated, periodically, in the medium at 10 g. 0·1 per cent. dust per cage, as a precaution against reinfestation. After the initial elimination of both mites from the colony, several generations of mite-free gnats were reared.

Cole (M. M.) & Clark (P. H.). **Tests with Compounds showing synergistic Action with Rotenone against Body Lice.**—*J. econ. Ent.* **51** no. 4 pp. 484–486, 10 refs. Menasha, Wis., 1958.

An account is given of laboratory tests on the control of *Pediculus humanus humanus* L. with rotenone in combination with selected compounds, some of which had previously been shown to have synergistic action with organic phosphorus insecticides [*cf. R.A.E.*, B **43** 48], allethrin [*cf.* **43** 104], cyclethrin [*cf.* **45** 175] or pyrethrins. When pieces of impregnated cloth were tested in beakers [*cf.* **34** 44–45] at 80°F. and 60–70 per cent. relative humidity, rotenone alone at concentrations up to 5 per cent. in acetone caused no mortality and sulfoxide [1,2-methylenedioxy-4-(2-(octylsulphinyl)propyl)benzene] alone, at 0·5 per cent., only 3 per cent.; the same amount of sulfoxide combined with rotenone at sulfoxide:rotenone ratios of 40:1 to 1:1 caused 92–95 per cent. mortality. Sulfoxide alone at 5 per cent. caused 95 per cent. mortality. When the compounds were diluted with pyrophyllite and applied as dusts to small cloth patches at the temperature and relative humidity previously used, 5 per cent. sulfoxide alone gave 58 per cent. kill initially, 78 per cent. after 92 days and 65–95 per cent. intermediately. Combined with 0·25–5 per cent. rotenone, it virtually always gave complete kill for 42 days or longer and gave 95–100 per cent. mortality after 56 days, and 90–100 per cent. after 92 days. Of 16 selected materials tested with rotenone at 1 and 0·1 per cent., respectively, in acetone on cloth in beakers, piperonyl butoxide, sulfoxide, 1,2-methylenedioxy-4-(2-(octylsulphonyl)propyl)benzene, 2-(3,4-methylenedioxyphenyl)-5-butyl-5-ethyl-m-dioxane [*cf.* **44** 16], the α-allylpiperonyl ester of fencholic acid and the 4-(3,4-methylenedioxyphenyl)sec.-butyl ester of chrysanthemic acid were the most effective. They were about equally effective in patch tests, but the chief action of all except piperonyl butoxide and sulfoxide was additive and not synergistic. In sleeve tests against a DDT-resistant strain of *P. h. humanus* on human subjects, a powder containing 0·5 per cent. rotenone and 5 per cent. sulfoxide gave complete control for 17 days and 97–100 per cent. mortality for 20–27 days, whereas one containing 0·2 per cent. pyrethrins and 2 per cent. sulfoxide gave complete control for ten days, 98 or 99 per cent. mortality for 13–17 days and 83–93 per cent. for 20–27 days.

Hansens (E. J.). **House Fly Resistance to Diazinon.**—*J. econ. Ent.* **51** no. 4 pp. 497–499, 3 refs. Menasha, Wis., 1958.

Diazinon [O,O-diethyl O-2-isopropyl-4-methyl-6-pyrimidinyl phosphorothioate] was first applied in dairy barns in New Jersey for the control of house-flies [*Musca domestica* L.] in 1952 [*R.A.E.*, B **41** 178–179] and was subsequently used there in the same barns for several successive years. In 1957, control was still generally good but perhaps less so than in previous years. Flies collected from four barns in which control was still excellent and from another on a farm on which failure of control had been reported in 1956 were exposed for 5 or 15 minutes on plywood panels bearing deposits of 1 mg. diazinon per sq. in. from an emulsified solution. There was evidence of the presence of diazinon-resistant flies in all five strains, and the degree of resistance was proportional to the amount of diazinon used in the barns during the preceding years. It was greatest in strains from barns in which diazinon had been used for five years.

The least susceptible strain was reared in the laboratory for four generations without appreciable loss in resistance. To select further for resistance, the flies of succeeding generations of this strain that survived exposure to deposits of diazinon (1 mg. per sq. in.) for 15 minutes, when four days or one day old, were used for breeding, and two more strains were thus established. Resistance increased very rapidly when selection was made from flies that were one day old when exposed, since they had not mated by that time. In as few as three generations, only 3–4 per cent. of the flies of this strain were killed by an exposure that gave complete kill of the non-resistant laboratory strain. When flies four days old were used, increase in resistance was less rapid. Less resistance was shown by the 1-day-old than by the 4-day-old flies [*cf.* **47** 165]. All three strains showed resistance in the fourth generation to diazinon, DDT, methoxy-DDT (methoxychlor), chlordane, dieldrin, γ BHC (lindane), parathion, malathion, dicapthon [O,O-dimethyl O-2-chloro-4-nitrophenyl phosphorothioate (Am. Cyanamid 4124)], Dow ET-57 [purified O,O-dimethyl O-2,4,5-trichlorophenyl phosphorothioate], Dipterex [dimethyl 2,2,2-trichloro-1-hydroxyethylphosphonate] and Bayer 21/199 [O,O-diethyl O-3-chloro-4-methyl-7-coumarinyl phosphorothioate] in comparison with a non-resistant laboratory strain. Resistance was directly related to the intensity of the selection that each strain received through exposure to diazinon.

Flynn (A. D.) & Eden (W. G.). **Systemic Insecticidal Action on Blood-sucking Ectoparasites of several Compounds administered orally to Rabbits.**—*J. econ. Ent.* **51** no. 4 pp. 499–501, 6 refs. Menasha, Wis., 1958.

In continued experiments to find compounds showing systemic insecticidal activity in animals [*cf. R.A.E.*, B **46** 80, 139, etc.], fifth-instar nymphs of the bed-bug (*Cimex lectularius* L.) were allowed to feed on rabbits to which one of 28 synthetic organic compounds had been administered orally as an acetone or water solution or an acetone-water emulsion. Five of the compounds showed systemic activity against *C. lectularius* at the highest dosages that failed to produce visible toxic symptoms in the rabbits. These compounds (as cited) and (in brackets) the rates at which they had been administered to the rabbits in mg. per kg. body weight and the percentage mortality, after 1 and 6 days, of bed-bugs fed to repletion one hour after the rabbit had received the chemical were Bayer 18613 (ethylglycolate-(O,O-diethyl phosphorothioate)) (1100, 20, 90), Bayer 19596 (O,O-diethyl S-acetoethylcarbamate phosphorodithioate) (625, 100, 0), Bayer 19994 (O,O-diethyl O-2-pyridino-(2)-ethyl phosphorothioate) (25, 90, 90), Bayer 13242 (O,O-diethyl

phosphoroacetothioate) (25, 100, 0) and Bayer 17364 (N-succinyl-ethylthio-S-(O,O-diethyl phosphorothioate)) (7, 100, 0). These five compounds were then tested against *Stomoxys calcitrans* (L.), *Aëdes aegypti* (L.) and nymphs of *Amblyomma maculatum* Koch. None of them showed systemic action against *Amblyomma* or *Aëdes*, and though they showed some indications of such action against *Stomoxys*, the results were inconclusive.

Burns (E. C.) & Goodwin (E. E.). **Tests with Dow ET-57 and Bayer 21/199 against Cattle Grubs in southwest Louisiana.**—*J. econ. Ent.* **51** no. 4 p. 545. Menasha, Wis., 1958.

The experiments described on the treatment of cattle with Dow ET-57 [purified O,O-dimethyl O-2,4,5-trichlorophenyl phosphorothioate] and Bayer 21/199 [O,O-diethyl O-3-chloro-4-methyl-7-coumarinyl phosphorothioate] for the control of *Hypoderma lineatum* (Vill.) and *H. bovis* (Deg.) were carried out in Louisiana in 1957 and were designed to determine the best time to effect treatment in order to control the larvae in the youngest possible stage [*cf. R.A.E.*, B **46** 165, etc.] and the relative effectiveness of several rates of Bayer 21/199. This compound was applied as a wettable-powder spray at 0·5 U.S. gal. per animal, and ET-57 was given as a bolus at 100 mg. per kg. estimated body weight. In the first experiment, a dozen cows were treated on 20th June with a 0·75 per cent. spray of Bayer 21/199 and a similar number with Dow ET-57. Half of each group received a second identical treatment on 20th August, and two more groups of six cows each were treated on 20th August only. A group of four cows was kept as an untreated control. ET-57 gave 79 per cent. control in June, 93 per cent. in August and 96 per cent. when used twice. The double and late applications of Bayer 21/199 were completely effective. The early application gave only 56 per cent. control, but heavy rain one hour after spraying was no doubt responsible for this. In a second experiment, with larger numbers of animals, Bayer 21/199 gave 96–100 per cent. control when applied at 0·75 per cent. on 20th June, at 0·5 per cent. on 18th, 26th or 27th July or at 0·25 per cent. on 26th July, and ET-57 gave 91, 83·9 and 85·1 per cent. control when applied on 20th June and 18th and 26th July, respectively.

Schoof (H. F.) & Kilpatrick (J. W.). **House Fly Resistance to Organophosphorus Compounds in Arizona and Georgia.**—*J. econ. Ent.* **51** no. 4 p. 546, 5 refs. Menasha, Wis., 1958.

Failure of malathion to control house-flies (*Musca domestica* L.) [*cf. R.A.E.*, B **47** 26, 85, 164] was reported in August 1957 from a fowl ranch (Anderson) near Savannah, Georgia, on which malathion dry bait had been used continuously from 1955 to the end of 1956, parathion-impregnated cords [*cf.* **46** 43] had been installed in late 1956 and both malathion baits and sprays had been used in 1957. A grill index [**38** 158] of 135 was obtained on 10th September 1957, and a dry poison bait containing 2 per cent. malathion and 0·25 per cent. DDVP [dimethyl 2,2-dichlorovinyl phosphate] was applied at 4 oz. per 1,000 sq. ft. [113·4 mg. per sq. ft.] on plywood trays but did not reduce densities noticeably. Following an application of spray to leave a deposit of 200 mg. malathion and 500 mg. sugar per sq. ft. on all potential resting surfaces on 18th September, the index fell to 69 flies on 20th September but rose again to 104 on 26th. A liquid bait of 0·1 per cent. DDVP and 10 per cent. sugar [**44** 175] on cellucotton pads then effectively reduced the population. Subsequent laboratory exposure of field-collected flies for 30 minutes on plywood panels treated one week earlier with 200 mg. malathion and 500 mg. sugar per sq. ft. or eight weeks

earlier with 200 mg. DDT per sq. ft. gave mortalities of only 8 and 2 per cent., respectively, in 24 hours. A colony was then established, without selection, from this strain, and the dosages in μg. per fly of malathion, diazinon [O,O-diethyl O-2-isopropyl-4-methyl-6-pyrimidinyl phosphorothioate] and parathion needed to give complete mortality in 24 hours of topically treated 3-day-old females of it were 72, 0·5 and 0·1, as compared with 0·5, 0·1 and 0·05 for a laboratory strain. Behaviouristic resistance similar to that in the Bethesda strain [**47** 165, etc.] was observed in the Anderson strain.

In August 1957, it was reported that diazinon was no longer effective in dairy barns near Phoenix, Arizona. In one dairy (Sharp), 26 applications throughout the premises of 2 or 2·5 per cent. malathion with 12·5 per cent. sugar in an emulsion spray gave excellent control in 1954 and 1955, and effectiveness remained steady in early 1956, but it decreased in July, and a spray of 1 per cent. diazinon and 6·25 per cent. sugar was substituted. This was effective until June 1957, when control became poor. Three treatments of diazinon and sugar and one each of diazinon and DDVP and malathion and sugar between 19th June and 20th July failed to give sustained control. Parathion and diazinon cords installed in mid-August reduced fly densities but did not keep them at a satisfactory level. A colony from the strain from this dairy was established at Savannah, without selection. Exposure for 30 minutes on deposits of 200 mg. malathion and 500 mg. sugar, 100 mg. diazinon and 250 mg. sugar, or 200 mg. DDT per sq. ft. one week after application caused only 1 per cent. mortality of females three days old. The dosages in μg. per fly giving complete mortality in 24 hours when applied topically to females of this strain were 66 for malathion, more than 1 for diazinon and 0·5 for parathion. The strain was about as resistant to malathion as the Bethesda-45 strain [**47** 165], but slightly less so than the Anderson strain; it was more resistant than either to diazinon and parathion.

Maddock (D. R.) & Fehn (C. F.). **Human Ear Invasions by Adult Scarabaeid Beetles.**—*J. econ. Ent.* **51** no. 4 pp. 546–547, 1 graph, 2 refs. Menasha, Wis., 1958.

The ears of 186 out of 52,580 boys in a camp in Pennsylvania became infested by Lamellicorn beetles in July 1957. The species involved were *Cyclocephala borealis* Arr. and *Ascrica* (*Autoserica*) *castanea* Arr. The presence of the beetles and their removal were very painful, but the effects were transitory and secondary infections were rare. Except for two instances in which beetles flew directly into the ears of boys standing in lighted areas, only boys sleeping on the ground were affected. No beetles entered the ears of persons sleeping in camp beds. Invasion of the ears occurred between 11 p.m. and 1.30 a.m., during the emergence of the beetles from the turf, or near sunrise while they were returning.

Taylor (M. L.) & Olinger (L. D.). **An Egg Survey of *Hippelates* Gnats in the Vicinity of Orlando, Florida.**—*J. econ. Ent.* **51** no. 4 p. 557. Menasha, Wis., 1958.

Vegetable fields, *Citrus* groves, flower beds and lake margins near Orlando, Florida, were surveyed during the summer of 1956 for eggs of *Hippelates*. The principal species involved were *H. pusio* Lw. and *H. bishoppi* Sabrosky, but no attempt was made to distinguish the eggs. An area of soil 4 in. in diameter was enclosed by a short length of copper piping, the top half-inch was collected, screened and transferred to a pan, and the eggs were separated from it by flotation in a 3:1 mixture of water and magnesium sulphate. The total number of eggs per sq. ft. and (in brackets) the numbers hatching

per sq. ft. from samples from the four types of area were 12·9 (6·8), 8·7 (5·6), 6·8 (4·7) and 0, respectively. Soil containing 5–15 per cent. moisture was most favoured for oviposition, and it had to be comparatively loose. Eggs were collected from soil ranging in pH from 5·8 to 7·6. The average number found per sq. ft. in a typical summer month was about 11 and the number hatching about 7. Tests in which a plot of soil in a *Citrus* grove and one in a vegetable area were freed of eggs and parts of them were exposed in turn to ovipositing females for six hours showed that no eggs were laid between 9 p.m. and 3 a.m., 16 between 9 a.m. and 3 p.m. and 9 in the remaining periods, when there were about half as many daylight hours.

RAFFENSPERGER (E. M.). **The Effects of Dow ET-57 on Chicken Shaft Louse Infestations.**—*J. econ. Ent.* **51** no. 4 pp. 558–559. Menasha, Wis., 1958.

The possibility of using Dow ET-57 [purified O,O-dimethyl O-2,4,5-trichlorophenyl phosphorothioate] as a systemic insecticide for the control of *Menopon gallinae* (L.) by administering it internally to fowls was investigated in Virginia in 1956 and 1957. A pilot test indicated that about 250 mg. per kg. body weight would be needed, and the insecticide at this dosage did not interfere with the hatching of eggs collected during the test and incubated under commercial conditions. Single doses of 250–1,000 mg. per kg. of Dow ET-57 as a 50 per cent. emulsifiable concentrate were then administered orally by calibrated syringe and catheter to groups of ten heavily infested laying hens. One untreated male bird with a severe infestation was kept with each treated group as a source of reinfestation. All treated hens were free of lice on the fourth day except for one that had received the lowest dosage. There was no reduction in infestation on a group of untreated hens. Two hens that had received the highest dosage showed typical signs of phosphate-insecticide poisoning on the fourth day and died on the fifth. Pneumonia was involved as a complication. In the latter part of the observation period of 30 days, louse populations on hens that had received 250 or 500 mg. increased rapidly, but hens that had received 750 or 1,000 mg. developed only small infestations. In a search for an easier means of administering the insecticide, the acceptability of standard mash into which Dow ET-57 had been incorporated as a 25 per cent. wettable powder was investigated. The amount of feed refused rose with an increase in the amount of the compound incorporated with it, and when the mash was treated with 500 parts Dow ET-57 per million the drop in food consumption during a six-day test was such as to lead to a prohibitive loss of production, yet louse infestation was not affected. Feeding dropped off rapidly before the amount of insecticide consumed reached 25 mg. per kg. per day.

TURNER jr. (E. C.) & HARGETT (L. T.). **The Effect of residual Barn Sprays on Control of Horn Flies.**—*J. econ. Ent.* **51** no. 4 pp. 559–560, 2 refs. Menasha, Wis., 1958.

It has recently been found that treatment of the walls, ceiling and stanchions of dairy barns with diazinon [O,O-diethyl O-2-isopropyl-4-methyl-6-pyrimidinyl phosphorothioate] to control house-flies (*Musca domestica* L.) also reduces numbers of horn flies (*Siphona irritans* (L.)) on cows brought to the barns for milking and feeding [*R.A.E.*, B **45** 36, 116]. Tests were therefore carried out to determine whether *S. irritans* could be effectively controlled by such sprays of diazinon or other insecticides similarly applied, and direct spraying of cattle thus rendered unnecessary. In preliminary

tests in the summer of 1956, sprays of 1 per cent. diazinon, 1 per cent. technical Dow ET-57 [O,O-dimethyl O-2,4,5-trichlorophenyl phosphorothioate] and 0·3 per cent. γ BHC (as lindane), all prepared from 25 per cent. wettable powders and applied to barns under high pressure, gave satisfactory control of *S. irritans* for 2–7, 1 and 2–3 weeks, respectively, as shown by counts of flies made in the pastures on 10 cows selected at random in each herd, a reduction of less than 60 per cent. from pretreatment counts being considered unsatisfactory.

In another series of experiments in 1957, sprays of 0·5 per cent. methoxy-DDT (methoxychlor) with ventilation of the barns when the cows were in the pastures and 1 per cent. malathion with or without ventilation failed to give satisfactory control even for one week, 0·3 per cent. γ BHC, 1 per cent. Dow ET-57 and 0·25 per cent. Bayer 21/199 [O,O-diethyl O-3-chloro-4-methyl-7-coumarinyl phosphorothioate] gave satisfactory control for three weeks without ventilation and for 1–2, 2–3 and 1–3 weeks, respectively, with it, and 1 per cent. diazinon gave satisfactory control for seven weeks without ventilation and for five weeks with it. A count of less than 50 flies per animal was considered to indicate satisfactory control, since an untreated check herd never showed less than 70 and averaged 138.

EL-ZIADY (S.). **The Behavior of *Ornithodoros erraticus* (Lucas, 1849), small Form (Ixodoidea, Argasidae), towards certain environmental Factors.**—*Ann. ent. Soc. Amer.* **51** no. 4 pp. 317–336, 12 figs., 16 refs. Washington, D.C., 1958.

The following is largely based on the author's summary. The reactions of females of the small form of *Ornithodoros erraticus* (Lucas) [*R.A.E.*, B **41** 193] to temperature, humidity, smell, gravity and light were investigated in the laboratory, in circular arenas over water tanks, to provide background data for further field studies on the biology, ecology and epidemiological significance of this tick in Egypt [*cf.* **44** 108]; the arenas were formed by glass rings, 2·5 cm. high and 15 cm. in diameter, surmounted by glass covers and with floors of perforated zinc covered by voile. When kept at uniform temperatures, the ticks crawled actively, mostly in circles, at 70, 84 and 94°F. but were very sluggish at 104 and 110°F., crawling with half the body lifted on the wall of the arena. Engorged females, offered a choice of high and low temperatures, avoided the high temperature when the difference between the alternatives exceeded 10°F.; the intensity of the reaction increased in proportion to the amount of temperature difference in the two halves of the testing arena. Hungry ticks moved freely from one side of the arena to the other, even when the hotter side of the arena was at 106°F., but not when it was at 110°F.

Reactions to relative humidity, which were investigated at 80°F., were influenced by feeding condition. Engorged females in a gradient of 18, 33, 75, 95, 98 and 100 per cent. relative humidity preferred the low and medium humidities (18–75 per cent.) and avoided the high ones (95–100 per cent.). They also preferred the lower humidities when offered alternatives of 98 and 18 per cent., 95 and 18 per cent., 95 and 33 per cent., 95 and 62 per cent. and 95 and 75 per cent. When offered 95 and 83, 95 and 98 or 95 and 100 per cent., they attempted to avoid both humidities. The optimum relative humidity for engorged ticks was 75 per cent. Hungry ticks preferred 95–100 per cent., their optimum appearing to be 95 per cent. Pre-conditioning experiments, in which ticks were kept at relative humidities of 95 per cent. (wet ticks) or 18 per cent. (dry ticks), indicated that the reactions of hungry individuals were influenced largely by their water balance. Hungry wet ticks first avoided the humid side of an arena, but returned to it when they

regained their normal water balance; desiccated hungry ticks rested in the humid portion. Desiccated engorged ticks avoided the dry side, whereas wet engorged ticks avoided the wet side.

Smell appeared to have no influence on host finding. Hungry individuals detected a host only after coming into actual contact with it and engorged from any body region, particularly where there was little hair. The ticks could, however, recognise an area contaminated with the scent of a host. The scent of freshly cut hair of gerbils was more attractive than that of guineapigs, rabbits or dogs. The odour of host faeces had no special attraction. Hungry ticks are negatively geotactic and readily climbed up a vertical tube. Engorged ticks are positively geotactic. Although *O. erraticus* has no eyes, both hungry and engorged females appeared to be negatively phototactic and avoided light of any intensity. Hungry ones did so immediately; engorged ones reacted more slowly. The convexity of engorged ticks possibly hides light receptor organs on the anterior of the body.

The morphology of the sense organs is illustrated and described. The temperature of the air is perceived through the general body surface, possibly through the dorsal surface, while that of the substratum is perceived through the ventral body surface. Humidity perception occurs through the body surface and is affected by the disturbance of the water balance after feeding. No special organs sensitive to light were detected, but it appeared that the anterior half of the body contains such organs. Haller's organ is chemoreceptive and may help in detecting hosts at a very short distance. Contact chemoreceptors, palpal organs and tactile hairs of the palpi and mouth flaps are concerned with host discrimination.

Dow (R. P.) & Hutson (G. A.). **The Measurement of Adult Populations of the Eye Gnat,** *Hippelates pusio*.—*Ann. ent. Soc. Amer.* **51** no. 4 pp. 351–360, 3 figs., 7 refs. Washington, D.C., 1958.

The following is based almost entirely on the authors' abstract. A bait-trap of new design for collecting adults of *Hippelates* is described. It consists of a metal cylinder, of height 5 in. and diameter 7½ in., mounted on legs, with the lower end open but covered with screening to prevent the entry of larger insects. A dish of bait is placed on the screening and a collecting jar, having a cellulose-acetate funnel with a small hole at the apex fitted to its mouth, is inverted over a hole in the closed top and held in place by a metal collar. It was more durable and much more effective than the wooden trap that it replaced, which retained the bait odour, and it was used in south-western Georgia to catch large numbers of individuals of the group of *H. pusio* Lw. (*H. pusio* and *H. bishoppi* Sabrosky). Other species caught were easily recognised and removed from the collections. In large catches that included *H. bishoppi*, it was found that satisfactory estimates of numbers of *H. pusio* could be obtained by weighing the collections at a fixed humidity and determining the ratio of the species in samples of about 100 specimens. When the proportion of *H. bishoppi* in the catches falls below 10 per cent., the number of *H. pusio* can be estimated with the same reliability by identifying smaller samples. *H. pusio* reached its seasonal peaks from July to the end of September; *H. bishoppi* showed a similar pattern but appeared to decline more rapidly. *H. pusio* was caught in small numbers when traps were situated at a distance from any known attractants, with the object of sampling hypothetically uniform areas, but when traps were set beside animal enclosures it was taken in large numbers. The numbers of *Hippelates* trapped beside poultry pens, of which probably more than 90 per cent. were *H. pusio*, were significantly correlated with the numbers of fowls in the pens. Net and aspirator collections made near and on mammals

consisted almost entirely of *H. pusio*. The proximity of animal enclosures had little or no effect on the catches of *H. bishoppi*, and since this species was never taken under circumstances that would prove attractive to a mammalian or avian host, its numbers should not be included with those of *H. pusio* for epidemiological purposes. The numbers of *Hippelates* observed about human subjects were found unsuitable for calculating a prevalence index, even though they were found to be correlated with the size of trap catches in nine communities with a wide range of gnat prevalence during a period when trapping showed a marked seasonal change. Examples observed on and about the heads of children were significantly more abundant when the subject had a history of conjunctivitis, and also when the child was active in the open rather than inactive in the shade.

Telford (A. D.). **The Pasture *Aëdes* of central and northern California. Seasonal History.**—*Ann. ent. Soc. Amer.* **51** no. 4 pp. 360–365, 2 graphs, 8 refs. Washington, D.C., 1958.

The following is substantially the author's abstract of a study of four species of *Aëdes* made in central and northern California from 1953 to 1955. *A. squamiger* (Coq.) and *A. dorsalis* (Mg.) breed on the inter-tidal marshes of the coast. The former, a univoltine species that undergoes obligate summer diapause in the egg stage, occupies the marshes primarily during the winter and early spring; its diapause appears irreversible and is terminated by low winter temperatures, perhaps also by a shortened photoperiod. *A. dorsalis*, a multivoltine species, occupies the marshes primarily during the summer; winter dormancy of its eggs is believed to be a facultative diapause induced and terminated by environmental factors of which temperature is primarily important. *A. nigromaculis* (Ludl.) and *A. melanimon* Dyar [*cf. R.A.E.*, B **46** 7] breed in water resulting from intermittent irrigation in the inland valleys. Both were found to be multivoltine and probably undergo an egg diapause similar to that of *A. dorsalis*. Except for insignificant overlapping, these two species occupy separate ecological niches in the same general environment and do not compete directly with one another.

Markos (B. G.) & O'Berg jr. (A. G.). **Observations on the Survival of Mosquito Pupae on moist Soil.**—*Ann. ent. Soc. Amer.* **51** no. 4 pp. 383–389, 3 figs., 6 refs. Washington, D.C., 1958.

The following is substantially the authors' abstract. Field observations were carried out on the survival of pupae of *Aëdes nigromaculis* (Ludl.), *A. melanimon* Dyar [*R.A.E.*, B **46** 7], *Culex tarsalis* Coq. and *C. stigmatosoma* Dyar on moist, heavy soils in central California. The pupae were subjected to high temperatures, low humidities and lack of free water, but even under these severe conditions, large numbers of them remained alive for 24–48 hours, and absence of standing water did not prevent adult emergence. A simulated habitat designed to protect the pupae from these elements appreciably enhanced survival and subsequent emergence. The findings indicated that, in order to assure a high degree of effectiveness, account should be taken, in larvicide operations, of all damp depressions that may hold water periodically, even though for relatively short periods.

Sweatman (G. K.). **Life History, Non-specificity, and Revision of the Genus *Chorioptes*, a parasitic Mite of Herbivores.**—*Canad. J. Zool.* **35** no. 6 pp.641–689, 1 pl., 53 figs., 28 refs. Ottawa, 1957.

A technique is described by which reproducing populations of *Chorioptes* (*Sarcoptes*) *bovis* (Hering) were reared for 3–8 months in vials on epidermal

débris and hair of cattle. The vials were covered with bolting silk and embedded in paraffin wax in a large jar, which was sealed with petroleum jelly and kept in complete darkness at 35°C. [95°F.]. A relative humidity of 80 per cent. was maintained by a solution of sulphuric acid on the wax. The various stages in the life-cycle of the mite are described. These are the egg, larva, protonymph, deutonymph and adult, but in the case of the female, the terms pubescent female and ovigerous female are used for the deutonymph and adult, respectively. Both nymphal stages show sexual dimorphism. All stages feed during their motile periods. The débris, not the hair, supplied the food. Under the experimental conditions, the egg stage lasted four days, the larval and protonymphal stages and the deutonymphal stage in the male usually lasted 3–5 days each, and the pubescent-female stage 7–8 days. There was an obligatory quiescence lasting about one day between each motile stage, and the life-cycle from egg to egg took about three weeks (18–28 days). Egg-laying ovigerous females might live for as long as three weeks and non-laying females and adult males 7–8 weeks. The pubescent female is generally attached to an adult male by copulatory anal suckers throughout both its active and quiescent phases, but copulation takes place only at a precise moment during the female's final moult. Eggs were laid singly at the rate of about one a day for 3–16 days, without further fertilisation; they were not laid parthenogenetically. The presence of eggs from one female attracted other females to lay, so that communal groups were formed.

A review of records in the literature of infestation of various hosts by mites of the genus *Chorioptes* suggested that the latter have a cosmopolitan distribution on cattle and horses and that they show no apparent differences of behaviour on different hosts, the important sites of infestation being the feet and lower hind legs. Populations from the different hosts have hitherto been thought to be host-specific and to differ physiologically, although they showed little or no morphological difference, and a fresh specific or infra-specific name has been assigned to the mites as they were recorded from each fresh host. To examine the validity of these names and of the belief in host specificity, mites of the genus *Chorioptes* were obtained in Quebec from cow, horse, goat, sheep and llama (*Lama huanacus glama*) and were studied by a variety of methods. The mites from the five hosts survived, when maintained *in vitro* on epidermal débris from any of the hosts, to the second and third generations without apparent loss of vigour or any indication of sterility, and they all completed their life-cycle in the standard period of about three weeks; they were able to cross-breed and produce fertile progeny to the second generation, when maintained on epidermal material from either cattle or horses. Eggs from cattle, horse and llama, when transferred to epidermal débris from other members of the families of these animals, hatched on all the materials, and the varying degrees of subsequent development on the different materials were similar, irrespective of the hosts from which the mites were originally derived. Mites from oxen, sheep and goats gave almost identical results on epidermal material from three species of antelopes (which link oxen on the one hand to sheep and goats on the other) completing their life-cycle, regardless of their origin, on one species but not on the other two. Natural transmission was induced by keeping two uninfested goats with an infested heifer, and two uninfested calves, one with infested goats and the other with infested sheep; all developed reproducing mite infestations on at least two of their feet within three weeks. Moreover, examination showed the lice from the five hosts to be morphologically identical with each other in all the motile stages. The reconciliation of the last finding with differences shown in the published figures and comments of earlier workers is discussed, and it is concluded that the mites from the four domestic animals and the llama are identical; since those from the first four

animals represent the species known as *C.* (*Sarcoptes*) *bovis* (Hering, 1845), *C.* (*Symbiotes*) *equi* (Gerl., 1857), *C.* (*Sarcoptes*) *caprae* (Delafond & Bourguignon, 1857–58) and *C.* (*Dermatophagus*) *ovis* (Zürn, 1874), the last three names become synonyms of *C. bovis*.

In experiments to determine to what extent the mites were potentially ubiquitous, the life-cycle was completed *in vitro* on epidermal material from some individuals, but not all, of a variety of wild Cervids, Bovids and Equids, but death in the larval stage or prolongation of the early developmental stages with high mortality occurred on débris from other individuals of the same species and from a variety of other wild ungulates. Survival appeared to be related to the individual rather than the species. From these and other data, all except one of the remaining specific or infraspecific names in *Chorioptes*, including *C. cuniculi* Raill., 1893, are also synonymised with *C. bovis*. The exception is *C. texanus* Hirst, 1924, which was described from a domestic goat in Texas [*R.A.E.*, B **12** 105]. Finally, the susceptibility of different breeds of domestic stock to infestation was tested. The life-cycle was completed on epidermal material from 12 of 14 breeds of cattle, 2 of 3 breeds of goats, 3 of 15 breeds of horses and 5 of 13 breeds of sheep. It thus appears that domestic cattle are the important host species and that they have probably been primarily responsible for the cosmopolitan distribution of the mite.

Tendeiro (J.). **Nota prévia sobre o novo aparecimento de uma tsé-tsé, *Glossina palpalis palpalis* Robineau-Desvoidy, na Ilha do Príncipe.** [Preliminary Note on the Appearance of a Tsetse, *G. p. palpalis*, on the Island of Principe.]—*Garcia de Orta* **4** no. 1 pp. 47–48, 1 pl. Lisbon, 1956. (With a Summary in French.)

Fraga de Azevedo (J.), Tendeiro (J.), de Almeida Franco (L. T.), da Costa Mourão (M.) & de Castro Salazar (J. M.). **Notícia sobre a tsé-tsé da Ilha do Príncipe.** [Information on Tsetse in the Island of Principe.]—*T. c.* no. 4 pp. 507–522, 16 pls., 1 graph, 1 ref. (With Summaries in French & English.)

Tendeiro (J.). **Notícia sobre a tsé-tsé da Ilha do Príncipe . . . Information on the Tsetse in the Island of Principe.** (Abstracts in Portuguese, Spanish, French & English.)—*Comun. Conf. int. Africanistas ocident., S. Tomé 1956* **4** pp. 251–252. [London] Sci. Coun. Afr. S. Sahara [1958].

It is reported in the first paper that two small collections of *Glossina*, received from the Island of Principe in May 1956, were identified as *G. palpalis palpalis* (R.-D.), which had disappeared from the island as the result of a campaign more than 40 years before [*cf. R.A.E.*, B **4** 48]; the genitalia of both sexes are described and figured.

In the second paper, of which the third is a summary in four languages, an account is given of the reappearance of *G. p. palpalis* in Principe, and importation from the island of Fernando Po, some 125 miles distant, is considered to have been responsible, rather than the persistence of residual foci after the campaign of 1912–14 [*cf. loc. cit.*]. In a survey carried out with 2,029 traps of the Morris type [*cf.* **37** 110] or a modification of it, 106,000 tsetse flies were caught in the northern and central parts of the island, to which they seemed to be confined, the greatest numbers being found in the north and particularly in the north-east. Examination of the entire human population and of over 800 domestic animals showed no symptoms of trypanosomiasis and no trypanosomes; these were also not found in 6,500 tsetse flies dissected. A draft plan of campaign is described, the objects of which were to exterminate the tsetse and to prevent the

introduction of trypanosomes into the island and of the tsetse into the Island of S. Tomé.

Snowball (G. J.). **Ecological Observations on the Cattle Tick,** *Boophilus microplus* **(Canestrini).**—*Aust. J. agric. Res.* **8** no. 4 pp. 394–413, 6 graphs, 11 refs. Melbourne, 1957.

The following is virtually the author's summary. Studies were undertaken during 1948–50 on *Boophilus microplus* (Can.) under field conditions in southern Queensland to determine the duration of the non-parasitic stages, and to relate this information to tick incidence on cattle. In the area in which the observations were made, the population of ticks on cattle is high in summer and autumn and low in winter and spring. Each week throughout the investigation, engorged female ticks, freshly fallen from cattle, were exposed in a pasture plot and their subsequent history was recorded. Concurrently, observations were made on the change in tick population on a dairy herd on an adjacent farm.

Females exposed on the plot between April and July (late autumn to mid-winter) produced virtually no progeny, and there was evidence that the ticks in the pasture traversed by the dairy cattle showed a similar, though less severe, inhibition of reproduction. This failure to reproduce, combined with the dying out of larvae and protracted developmental periods of eggs [*cf. R.A.E.*, B **45** 160], reduced to very low levels the larval populations available to infest cattle during the months of August–October. Ticks exposed from late July to the following autumn produced progeny. There was a tendency for the progeny of ticks exposed in the late winter and early spring to hatch at about the same time in the late spring, and this synchronous hatching was probably responsible for the " spring rise " in tick population on cattle. It appears likely that the engorged adult females that drop in the early autumn represent the most important stage in the overwintering of the species in this area. Some of their larvae survive the adverse winter conditions, either in the free-living or the parasitic stage, and give rise to adults that fall in the late winter and spring and produce the larvae of the spring rise.

Wilkinson (P. R.). **The Spelling of Pasture in Cattle Tick Control.**—*Aust. J. agric. Res.* **8** no. 4 pp. 414–423, 3 figs., 16 refs. Melbourne, 1957.

The following is largely based on the author's summary. When two similar herds of cattle were kept continuously in adjoining pastures near Rockhampton, in central Queensland, acaricidal treatment was necessary about every 5–8 weeks to control *Boophilus microplus* (Can.). Thereafter, one of the two herds was grazed alternately in its own and an adjacent pasture, the intervals between each transfer being sufficient to ensure that most of the ticks in the unoccupied pasture had died. Tick infestations on this herd were greatly reduced, and only one further spraying was necessary during a period when the herd remaining in the continuously stocked pasture needed three further treatments for recurring tick infestation.

In a field trial with 350–400 cattle moved at intervals of 2–3 months to each of three formerly heavily infested pastures, tick infestations remained very light, although the herd was dipped only in January, September and the following January. A control herd on continuously stocked pasture, treated at the owner's discretion, required eight dippings in this period. This procedure of temporary destocking (termed " pasture spelling ") seems likely to be widely applicable in central Queensland, where a certain amount of tick infestation must be maintained, so that the cattle do not lose their immunity from piroplasmosis [*Piroplasma bigeminum* and *P. argentinum*].

Stone (B. F.). **Resistance to DDT in the Cattle Tick, *Boophilus microplus* (Canestrini).**—*Aust. J. agric. Res.* **8** no. 4 pp. 424–431, 7 refs. Melbourne, 1957.

The following is largely based on the author's summary. Difficulty was experienced in controlling *Boophilus microplus* (Can.) on a herd of cattle at Rockhampton, in central Queensland, by dipping in 0·5 per cent. w/v p,p′DDT. The herd had been treated with dips containing γ BHC and DDT, or DDT alone, for nearly 5 years previously. When a steer artificially infested with ticks of the Rockhampton strain was sprayed with 1 per cent. w/v p,p′DDT in colloidal suspension, only 26 per cent. of the engorged females that fell from the animal over the 48-hour period after spraying failed to lay viable eggs, as compared with 64 per cent. of those of a reference strain that fell from a similarly treated steer. The reference strain had been maintained in the laboratory for 9 years without acaricidal treatment and had never been exposed to chlorinated hydrocarbons. Both strains were equally susceptible to diazinon [O,O-diethyl O-2-isopropyl-4-methyl-6-pyrimidinyl phosphorothioate] at 0·08 per cent., 87 and 89 per cent. of the engorged females that fell in 24 hours failing to lay viable eggs. Laboratory concentration-response tests in which cultured ticks of the Rockhampton strain were dipped in colloidal suspensions of DDT indicated that the larvae were 22 times as resistant to DDT as those of the reference strain, at the LD50 level. The engorged females probably had resistance of the same order, but as the highest concentration tested prevented only 10 per cent. of them from laying viable eggs, accurate determination of the LD50 was impossible. The Rockhampton strain showed no significant resistance to dieldrin or toxaphene, and did not appear to have developed any resistance to BHC in spite of the early use of this acaricide. There was no difference in susceptibility to DDT between adults of an "early-falling" and a "late-falling" substrain of the resistant strain after selection for three generations.

Foster (R.). **Observations on Laboratory Colonies of the Tsetse Flies *Glossina morsitans* West. and *Glossina austeni* Newstead.**—*Parasitology* **47** (1957) no. 3–4 pp. 361–374, 8 refs. London, 1958.

The following is largely based on the author's summary. A breeding colony of *Glossina morsitans* Westw. was maintained [*cf. R.A.E.*, B **42** 98] in individual specimen tubes measuring 3 × 1 in. and covered with mosquito-netting through which the flies fed. Best results were obtained at temperature and relative-humidity ranges of 74–80°F. and 60–75 per cent., respectively. Young flies did not tolerate a lower minimum temperature. A light intensity of at least one foot-candle was needed at the feeding site. The method of feeding was important. Best results were obtained if food was offered every fourth day, at a temperature of 80–81°F., as more frequent opportunity led to partial feeding and this was harmful to reproduction. If a fly failed to feed, it was offered food daily until it did so, and the four-day cycle was then resumed. Newly emerged flies were offered food daily until they had taken three meals. Pupal production was best with sheep as the host animals, but guineapigs were useful for inducing newly emerged or other reluctant flies to feed. It was important that the skin at the feeding site should be supple, and it is suggested that frequent replacement of the host animal by a fresh one would improve feeding. Female flies lived longer than males, and the mortality in both sexes was higher during the first 20 days of life. Mating took place in the tubes, the male being transferred to the female's tube and left there for 17–24 hours. The optimum age for mating was 10–14 days for males and 3–4 days for females; 90–100 per cent. of females of the first and second generations were fully inseminated.

Over three generations, each generation was less vigorous than the preceding one. Pupal production fell and the abortion rate rose from each generation to the next. The first generation comprised 259 males and 280 females and the third 29 males and 39 females. Pupal viability, however, remained constant throughout the three generations. Mean pupal weight was less in the progeny of the first generation than in that of wild flies and showed a further decrease in the next generation. Pupae produced by the flies of the second and third generations, however, weighed about the same. The duration of an interlarval period was directly correlated with the length of the maximum interval without food during the period, regardless of the stage of the interlarval period at which the maximum foodless interval occurred. It increased from a mean of 12·04 when the maximum interval was three days to 46·75 when the maximum interval was 11 days. The mean interval without food during the period did not affect the duration of the latter. Feeding on the day of larviposition did not significantly affect the length of the succeeding interlarval period.

A colony of *G. austeni* Newst. was maintained in a similar manner, but results with this species were best at 80–85°F. and 77–82 per cent. relative humidity. Feeding was more satisfactory than with *G. morsitans*, and females generally lived longer and produced more pupae.

Kissling (R. E.), Chamberlain (R. W.), Sudia (W. D.) & Stamm (D. D.). **Western Equine Encephalitis in wild Birds.**—*Amer. J. Hyg.* **66** no. 1 pp. 48–55, 20 refs. Baltimore, Md., 1957.

Six species of wild birds common in the south-eastern United States, the purple finch (*Carpodacus purpureus purpureus*), cardinal (*Richmondena cardinalis*), English sparrow (*Passer domesticus*), white-throated sparrow (*Zonotrichia albicollis*), towhee (*Pipilo erythrophthalmus*) and blue jay (*Cyanocitta cristata*), were found to be highly susceptible to a strain of the virus of western equine encephalitis (WEE) originally isolated from a pool of females of *Culiseta melanura* (Coq.) in Louisiana in 1952 [*cf. R.A.E.*, B **44** 136]. They were infected by subcutaneous inoculation or by the bite of infected mosquitos. Maximum titres of virus circulating in the blood ranged from $10^{2\cdot4}$ to $10^{6\cdot5}$ mouse-intercerebral LD50's per 0·03 ml. blood [*cf.* **44** 38] when 3 LD50 units were inoculated and from 10^4 to $10^{6\cdot7}$ when 350 LD50's were inoculated. Birds to which infection was transmitted by *Aëdes triseriatus* (Say) developed similar titres to those that had received the virus by inoculation. The concentrations of virus in the birds were adequate to infect females of *A. triseriatus* and *A. aegypti* (L.), which transmitted infection from the experimental examples to normal ones by bite. The amount of WEE virus recovered from infected females of *A. triseriatus* 11–13 days after the infective feed was generally no greater than that initially ingested, but increases as great as 2,000-fold were found in *A. aegypti*. Virus was isolated from a batch of eggs laid by a pool of WEE-infected females of *A. triseriatus*. It is not known whether the embryos were actually infected and might have produced infected adults or whether virus had merely remained viable on the surface of the eggs.

The reasons of the failure of epidemic WEE to become epidemic in the eastern United States, where *A. triseriatus* is common, are discussed. It is apparently not due to an inherent lack of susceptibility in indigenous birds and probably not to low infectivity of the virus strains occurring in the east. It is suggested that the habits of the potential vectors may be an important factor. *Culex tarsalis* Coq., a very effective vector in the west, feeds frequently on horses and man as well as on birds, its preferred hosts, and can probably serve as both an endemic and an epidemic vector. In the east, however, in the absence of *C. tarsalis*, enzootic infection in wild birds is

apparently transmitted by mosquitos that are more strictly bird-feeding. If outbreaks in man or horses occurred in the east, they would most probably be propagated by other species with preferences for mammalian blood, and the populations of the latter would have to be very high for enough chance feeding to occur on birds and for infection to be carried from them to horses and man. Moreover, most eastern mosquitos that might serve as epidemic vectors have higher infection thresholds [**44** 40] than *C. tarsalis* [**46** 11]. Although the divided host preferences of vectors in the east probably tend to limit the extent to which horses and man are infected with eastern equine encephalitis (EEE) as well as with WEE, higher infection rates and virus titres in wild birds and the weakening and death of a higher percentage of infected small birds, making them more accessible to diurnal mosquitos, appear to combine to allow EEE to attain epidemic status.

Lee (D. J.), Dyce (A. L.) & O'Gower (A. K.). **Blood-sucking Flies (Diptera) and Myxomatosis Transmission in a Mountain Environment in New South Wales.**—*Aust. J. Zool.* **5** no. 4 pp. 355–401. 2 pls., 4 figs., 8 refs. Melbourne, 1957.

The following is largely based on the authors' summary and conclusions. The possible vectors of myxomatosis amongst rabbits in a typical mountain environment in eastern New South Wales were investigated in 1952–54. The disease was introduced into an isolated population of rabbits with no previous history of myxomatosis and the course of its fluctuations followed through a period of two and a half years, involving two large-scale reductions in rabbit density. There was evidence that transmission continued throughout the colder months. Of over 60 species of blood-sucking Diptera identified, nine species of mosquitos and two Ceratopogonids were shown to attack rabbits. Two recoveries of myxomatosis virus were made from mixed collections of *Aëdes queenslandis* (Strickl.) and *A. alboannulatus* (Macq.) [*cf. R.A.E.*, B **45** 208]. The former is the dominant species of the area. It favours sheltered, vegetated rocky creeks, and adults are present throughout the year.

The relative importance of the species known to attack rabbits is discussed in relation to the transmission and maintenance of the disease, and data are given on the host preferences of all and on the seasonal occurrence, feeding, resting places, activity and breeding habits of most of them. Eggs of *A. queenslandis*, a rock-hole breeder, are apparently normally deposited on moist, granular surfaces and are unable to withstand air-drying, so that hatching depends on a frequently fluctuating water-level. They can survive in a moist condition, without actual immersion, for at least five months. The interval between immersion and hatching is very variable. Recently formed temporary pools in incipient gullies invariably showed high populations of larvae of *A. alboannulatus* that must have hatched from eggs present in the dried pool before it refilled. This suggests oviposition at the margin of receding temporary pools. Larvae of these two species and of three others were present at all seasons, but numbers of *A. alboannulatus* fluctuated considerably. Both *A. queenslandis* and *A. alboannulatus* fed freely on rabbits and marsupials [*cf.* **44** 125], and "double" feeding is known to occur in the latter. *A. notoscriptus* (Skuse) was as abundant as *A. alboannulatus*, but the larvae were confined to very small rock-pools heavily polluted with leaf débris. It was fairly uniformly distributed throughout the year and fed readily on rabbits.

No correlation between species abundance and epizootic incidence was detected. Numbers of mosquitos attracted to human bait were as high in winter as in summer. Epizootics in coastal and tableland areas of southern New South Wales and eastern Victoria have occurred in autumn only. It is

believed that some form of behaviour, possibly meteorologically determined, occasioning wider contact between mosquitos and rabbits, occurs with greater regularity during autumn.

Galliard (H.) & Golvan (Y. J.). **Influences de certains facteurs nutritionnels et hormonaux, à des températures variables, sur la croissance des larves d'***Aedes* (*S.*) *aegypti*, *Aedes* (*S.*) *albopictus* **et** *Anopheles* (*M.*) *stephensi*.—*Ann. Parasit. hum. comp.* **32** no. 5–6 pp. 563–579, 6 figs., 24 refs. Paris, 1957.

With a view to obtaining large adults of *Aëdes aegypti* (L.), *A. albopictus* (Skuse) and *Anopheles stephensi* List. as rapidly as possible at comparatively low temperatures, the effect of various diets was examined on batches of 50 larvae of the first two species at different temperatures but under otherwise similar conditions and of the last at one temperature. Controls were fed on powdered dog biscuit or, at low temperatures, on guineapig faeces. Mean temperature was found to be of paramount importance as regards larval size as well as duration of development. Within limits, extremes of temperature were unimportant.

For *Aëdes aegypti*, on which more tests were carried out than on the other species, the duration of development increased as the mean temperature fell and was least at each temperature on a diet of milk proteins, with which adults were obtained in 5 days at 28°C. [82·4°F.] and in 20 days at 17°C. [62·6°F.]. The size of the fourth-instar larvae also increased with decreasing temperature and was somewhat greater on some of the other diets, notably guineapig faeces, than on the milk proteins. The addition of antibiotics to a protein-rich diet was beneficial at high temperature, since it prevented the excessive development of bacteria, which causes mortality among larvae and, more especially, pupae. At 17°C., on the other hand, it seemed to retard development, as bacteria were never sufficiently plentiful to be harmful, but seemed on the contrary to have a beneficial effect. Thyroxin favourably affected both rate and degree of growth, and vitamin B12 had a smaller favourable effect. The results with *A. albopictus* indicated similar trends, but this species was more difficult to rear. Development was slower, requiring 25 days at 18°C. [64·4°F.] and 10 days at 25°C. [77°F.] on the milk-protein diet, and the addition of antibiotics was advantageous even at 18°C. *Anopheles stephensi* was reared at 25°C., and development followed the same lines as in *Aëdes aegypti*, lasting 7 days on the milk-protein diet.

It is concluded that to obtain large adults reasonably quickly, temperature must be kept below 20°C. [68°F.], as slower development favours growth when the diet is rich in protein. Antibiotics should be added for delicate species but not for robust ones. To obtain adults very quickly, rearing must be carried out at a temperature above 25°C. with a protein-rich diet to which antibiotics have been added. The retarding effect of low temperature was most marked in the fourth larval instar and pupal stage. The control diet of dog biscuit was reasonably adequate at high temperatures but quite inadequate at low ones.

Papers noticed by Title only.

Fisk (F. W.). **Toxicity of BHC in Milk to House Flies as related to Butter Fat Content of the Milk.**—*J. econ. Ent.* **51** no. 4 pp. 560–561, 6 refs. Menasha, Wis., 1958. [See *R.A.E.*, A **47** 437.]

Johnson (P. T.). **A Classification of the Siphonaptera of South America with Descriptions of new Species.**—*Mem. ent. Soc. Wash.* no. 5, $10\frac{1}{4}$ × 7 in., [6+] 299 pp., 114 pls., $6\frac{1}{2}$ pp. refs. Washington, D.C., 1957. Price $10.00 ($9.00 to members).

Price (R. D.). **A microscopic Study of *Pasteurella tularensis* in the Human Body Louse.**—*Parasitology* **47** (1957) no. 3–4 pp. 435–446, 1 pl., 1 graph, 17 refs. London, 1958.

In the third part of an investigation into the relationship between *Bacterium (Pasteurella) tularense* and *Pediculus humanus humanus* L. [*cf. R.A.E.*, B **43** 134; **44** 209], the lice generally acquired infection by feeding for 20–30 minutes on a rabbit immediately after it had received a massive dose of infective tularaemia organisms by inoculation into the marginal ear vein. For the study of the effect on the louse of the presence of *B. tularense* in the haemolymph, bacteria were injected directly into that cavity. The following is virtually the author's summary of the observations made. Tularaemia organisms may be abundant in the mid-gut lumen, the epithelial cells of the anterior third of the mid-gut and the haemolymph of the louse. Multiplication is extracellular in the lumen and the haemolymph and intracytoplasmic in the gut cells. The multiplication of the organisms in the mid-gut epithelium eventually leads to the disruption of these cells and the break-through of the organisms into the body cavity. Their growth in the haemocoele results in the death of the louse in 4–7 days. Lice vary greatly in their susceptibility to infection. Some show complete resistance to it; others can retain it essentially for their normal life span of 35 days; still others apparently succumb relatively quickly to a rapid increase of the organisms. The behaviour of *B. tularense* in the louse shows interesting similarities to infection of lice with the rickettsiae pathogenic to man [*cf.* **43** 76, etc.].

Bruaux (P.). **Toxicité de deux insecticides organo-phosphorés (diazinon et malathion) chez les travailleurs utilisant ces insecticides.**—*Ann. Soc. belge Méd. trop.* **37** no. 6 pp. 789–799, 3 refs. Brussels, 1957. (With Summaries in Flemish, English, German & Spanish.)

Determinations were made of blood-cholinesterase levels in 74 African workers in Léopoldville (Belgian Congo) who had never had contact with insecticides, in 36 others who had been employed in the application of emulsion sprays of diazinon (O,O-diethyl O-2-isopropyl-4-methyl-6-pyrimidinyl phosphorothioate) in public-health operations for the two years immediately preceding examination, or of diazinon for two years and then malathion for the six weeks immediately preceding examination, and in 36 who had been exposed to malathion for two years. The workers were poorly protected, but both these compounds, and particularly malathion, are reputed to be only very slightly toxic. The effect of malathion was in fact found to be weak, but the cholinesterase level in some of the workers exposed to diazinon was lowered to 20 per cent. of the normal. Toxic symptoms may occur at this level, though they have never been observed in Léopoldville, and the need for keeping strict observation on the effect of exposure to organophosphorus insecticides, particularly in Africa, is stressed, as the climate and the type of labour available combine to make the taking of special precautions impracticable. It is suggested that exposure should cease when the blood-cholinesterase level falls below 50 per cent. of normal.

Weinbren (M. P.), Williams (M. C.) & Haddow (A. J.). **A Variant of Rift Valley Fever Virus.**—*S. Afr. med. J.* **31** pp. 951–957, 10 refs. Cape Town, 1957.

A virus isolated from two pools of mosquitos of the genus *Aëdes* from Lunyo Forest on the Entebbe peninsula of Uganda, caught on man, resembled

that of Rift Valley fever (RVF) [*R.A.E.*, B **19** 207–208; **21** 163] in many respects, but it could not be neutralised with potent sera immune to RVF or with sera immune to 12 other viruses. The first isolation was made from a pool of *Aëdes* spp., preponderantly *A. circumluteolus* (Theo.), caught between 31st October and 4th November 1955, and the second from a suspension of females of *A. africanus* (Theo.) prepared in June 1956. In subsequent work, evidence was produced that *A. circumluteolus* was the species responsible for the presence of the first strain in the pool. The behaviour of the Lunyo virus in mice, and cross-neutralisation tests, which are described, suggest that it is a variant of classical RVF virus. The histological pictures produced by the two viruses in adult mice are different. The Lunyo virus was readily transmitted from mouse to mouse by females of *A. aegypti* (L.), though previous attempts to obtain transmission of RVF virus by this species had failed. Though the infecting virus was viscerotropic, passage through the mosquito resulted in its return to the neurotropic type. Evidence is presented that a virus isolated from a man showing symptoms suggestive of RVF infection may have been the Lunyo strain.

Hartzell (A.), Burchfield (H. P.) & Cotty (V. F.). **Improvements in culturing Larvae of *Aedes aegypti* (L.) for Use in Insecticide Bioassay.** —*Contr. Boyce Thompson Inst.* **19** no. 4 pp. 321–325, 4 refs. Yonkers, N.Y., 1958.

The authors describe improvements in the method previously adopted [*cf. R.A.E.*, B **42** 125] for rearing larvae of *Aëdes aegypti* (L.) for use in the bioassay of insecticides [*cf.* A **44** 127, etc.]. The principal changes include the use of deionised water, reconstituted to a standard ionic strength by the addition of physiological salt, as the rearing medium; adjusting the temperature to 31°C. [87·8°F.]; and altering the ratio of brewers' yeast, blood albumin and sucrose to 10:3:2 and the concentration of 0·25 per cent. nutrient suspension in water to 225 ml. per 8 litres. Under these conditions, second-instar larvae were obtained with great regularity 22 hours after the addition of the nutrient to the medium, which eliminated the need to segregate first-instar larvae and resulted in considerable saving of time and effort.

Mellanby (K.). **The Alarm Reaction of Mosquito Larvae.**—*Ent. exp. appl.* **1** no. 3 pp. 153–160, 14 refs. Amsterdam, 1958. (With a Summary in German.)

The following is virtually the author's summary of this account of laboratory experiments, in which the mosquito larvae used were those of *Aëdes aegypti* (L.), *Culex pipiens molestus* Forsk. and *Anopheles maculipennis atroparvus* van Thiel.

When *Aëdes* larvae are alarmed, they swim actively to the bottom; they recover by floating passively upwards. *Culex* and *Anopheles* larvae sink passively when alarmed; they swim actively to the surface on recovery. Repeated stimulation produces "stimulus satiation", but a different type of stimulus can then produce a complete response. Geotaxis and phototaxis are concerned in the alarm reaction in *Aëdes*; phototaxis can overrule geotaxis. The chill coma temperature of these larvae is several degrees cooler than the lowest temperature at which the alarm reaction takes place. Acclimatisation can alter the level of both.

Thorsteinson (A. J.). **The Orientation of Horse Flies and Deer Flies (Tabanidae, Diptera): I. The Attractance of Heat to Tabanids.**—*Ent. exp. appl.* **1** no. 3 pp. 191–196, 1 fig., 6 refs. Amsterdam, 1958. (With a Summary in French.)

Tabanid flies show a strong tendency to congregate in enclosures that accumulate heat during daylight, notably motor vehicles at rest. In order to study this behaviour and if possible to exploit it for control, a "heliothermal" trap that converts solar radiation into heat was designed and tested in Canada. It consists essentially of a plastic cone raised on three legs meeting at the apex, beneath which hangs a black funnel leading to a killing jar. Details of construction are shown in diagrams. The black funnel under the transparent cover accumulates heat below and inside the trap to attract the flies, and these then move to the restricted upper space, where, as a result of thermal stress, exhaustion, or, if desired, contact with an insecticide, they succumb and drop through the funnel. Field tests in 1957 showed the trap to be very effective in attracting *Tabanus* and sometimes *Chrysops*, and the purposes for which it may be used are discussed. It is specific for female Tabanids, and its effect in control is therefore cumulative over a period of years. It is most effective during the height of the season, when Tabanids are most active and pastures at their best for cattle grazing. Possible ways of improving it are suggested; a method of preventing the escape of the flies was found essential in the cooler season of 1958.

Wright (P.), Payne (K.) & Shanahan (G. J.). **A preliminary Evaluation of Insecticides and Methods of Application for the Prevention of Body Strike in Sheep.**—*Aust. vet. J.* **33** no. 9 pp. 227–229, 6 refs. Sydney, 1957.

The comparative effectiveness of diazinon [O,O-diethyl O-2-isopropyl-4-methyl-6-pyrimidinyl phosphorothioate], dieldrin, aldrin and BHC applied by different methods to protect sheep against body strike by blowflies in eastern New South Wales was investigated in experiments begun in May 1955. Merino ewes and wethers of mixed ages shorn in November were divided into a control group of 15 and 17 treatment groups of seven, which were jetted on the shoulders and the backs down to the mid-side at ½ gal. per sheep or sprayed on the same areas at ½ pint (low-volume spraying) or ½ gal. (high-volume spraying) per sheep. Control and treated sheep were allowed to run together in the same paddocks. Larvae were implanted on them [*R.A.E.*, B **26** 25] 16, 20 and 28 weeks after treatment. Difficulty in rearing flies during the winter prevented implants from being made sooner. Implanted larvae developed normally in all untreated sheep.

Diazinon (80 per cent.) applied by jetting gave complete protection for 28 weeks at 0·5 and 0·1 per cent. [*cf.* **46** 55], complete protection for 16 but only 83 per cent. after 20 and 28 weeks at 0·05 per cent., and 83 per cent. throughout at 0·025 per cent. [*cf.* **47** 130]. Applied as a low-volume spray at 0·5 and 0·25 per cent. and as a high-volume spray at 0·25 per cent., it gave no protection after 20 weeks and 0, 14 and 28 per cent. protection, respectively, after 16 weeks. Trials with the other materials were terminated after 20 weeks. Dieldrin applied by jetting at 0·5, 0·1, 0·05 and 0·025 per cent. gave 100, 100, 60 and 0 per cent. protection after 16 weeks and 43, 57, 40 and 0 per cent. after 20 weeks, and no protection as a low-volume spray at 0·5 per cent. Aldrin applied by jetting at 0·5, 0·1 and 0·05 per cent. gave 100, 78 and 30 per cent. protection after 16 weeks and 83, 50 and 14 per cent. after 20 weeks; as a low-volume spray

at 0·5 per cent., it gave 16 per cent. protection after 16 weeks and none after 20 weeks. BHC applied by jetting at 0·5 per cent. gave complete protection after 16 and 20 weeks and was not applied as a spray. The effectiveness of spraying within 16 weeks of treatment merits further investigation because of the saving of time and labour that would attend its substitution for jetting, but it is pointed out that, although it might have its uses when flies had become active and time was an important consideration, longer protection would be afforded when the fleece was wetted to the skin by jetting.

Skerman (K. D.) & Pryor (W. J.). **Prevention of Breech Strike in Merino Ewes by Jetting with Dieldrin and Diazinon.**—*Aust. vet. J.* **33** no. 9 pp. 230–232, 11 refs. Sydney, 1957.

The following is based on the authors' summary. Three field trials were carried out early in 1957 with 2,659 young Merino ewes to determine the effectiveness of dieldrin or diazinon [O,O-diethyl O-2-isopropyl-4-methyl-6-pyrimidinyl phosphorothioate] applied in emulsions by jetting at 0·025–0·05 and 0·01–0·04 per cent., respectively, in giving protection against breech strike by blowflies in Victoria. Most of the ewes were plain-breeched, and carried wool $\frac{1}{2}$–$\frac{3}{4}$ in. long in the breech region. They had been crutched 6–8 weeks earlier. The area treated comprised only the breech and a 4-inch band round the base of the tail; about 1 pint fluid was applied per sheep. Highly significant protection was given to treated as compared with untreated groups, during the 12 weeks after treatment, in all three trials (which included ewes of different ages). The numbers of treated sheep struck were too small to allow of precise evaluation of different concentrations of insecticides, but the trend was for protection to be similar when diazinon was used at half the dieldrin concentration [*cf. R.A.E.*, B **47** 130; also preceding abstract].

Norris (K. R.). **Strategic Dipping for Control of the Cattle Tick, *Boophilus microplus* (Canestrini), in south Queensland.**—*Aust. J. agric. Res.* **8** no. 6 pp. 768–787, 9 graphs, 10 refs. Melbourne, 1957.

Populations of the cattle tick (*Boophilus microplus* (Can.)) are reduced to low levels by the winter climate of southern Queensland, and the small numbers remaining have to be allowed to survive so that the cattle do not lose their immunity from redwater fever [caused by *Piroplasma bigeminum* and *P. argentinum*] [*cf. R.A.E.*, B **47** 176]. Dipping is usually resumed too late to prevent the development of very large populations in summer and carried out only when the need for it is obvious. Experiments on the possibility of maintaining populations at an easily controlled level by intensive dipping early in the season (strategic dipping) were made in 1953–54 and 1954–55. In the spring and early summer of 1953, three privately owned herds were dipped in acaricides (generally 0·5 per cent. p,p′DDT or 0·05 per cent. γ BHC) from September onwards at such intervals that few or none of the ticks attaching to the cattle between dippings reached maturity. This was continued until the larvae hatching in the pastures were greatly depleted in numbers but discontinued (usually in December) before they were exterminated. Throughout the rest of the summer and the early autumn, the cattle were only lightly infested and needed dipping relatively seldom. Moderate numbers of ticks falling in March were needed to ensure the survival of the population through the winter. There were very heavy infestations of ticks throughout the summer

and autumn, in spite of monthly dipping begun at the end of November, on a property on which early intensive dipping had not been practised. Results obtained by intensive early-season dipping in the 1954–55 season were not nearly so good as in the previous year. Although this may have been partly due to the fact that the minimum temperatures and the rainfall of the cool months were higher in 1954 than in 1953, the chief cause appeared to be delayed or relatively ineffective dipping at critical times. Dipping must be begun before the need for it is apparent, and the present evidence suggests that it should be begun in September rather than in October.

Effective strategic dipping, as during the 1953–54 season, would reduce the need for treatment in the summer and prevent the build-up of very heavy populations that can occur when urgently needed dipping is delayed by rain. The advantage seems to lie in improved control rather than in a reduction in the total number of dippings. Resistance to DDT [*cf.* **47** 177] is less widespread than resistance to arsenic [*cf.* **45** 59, etc.], BHC or toxaphene [*cf.* **46** 87, etc.], and DDT therefore remains the most generally useful acaricide, but it has the disadvantage that, as it does not kill the easily visible large adult females, its use has to be carefully timed, and this requires experience and close observation. The timing of dipping with BHC and other acaricides that kill engorging females is less critical. Where winters are appreciably milder than in southern Queensland, either the programme might have to be amended or its relation to season might have no advantage, but periods of intensive dipping would no doubt be useful in any area in which the tick attains pest proportions.

Dobrotworsky (N. V.). **Notes on Australian Mosquitoes (Diptera, Culicidae). II. Notes on *Anopheles stigmaticus* Skuse and Description of new Species of *Anopheles* from Australia and New Guinea.**—*Proc. Linn. Soc. N. S. W.* **82** pt. 2 pp. 180–188, 3 figs., 6 refs. Sydney, 1957.

Anopheles stigmaticus Skuse has been recorded as having a wide distribution from New South Wales through Queensland to New Guinea, but it is clear that a number of closely allied forms have been confused under the one name. E. N. Marks recognised five components of the complex in Queensland in 1956 and named one of them *A. colledgei* [*R.A.E.*, B **46** 148]. Most members of the complex are restricted to mountainous areas, up to 6,000 ft. Those that occur in coastal plains breed only in shaded situations [*cf.* **38** 202]. The water temperature of the breeding sites seldom exceeds 20°C. [68°F.] in southern Australia, and Marks has stated that this applies in Queensland also.

When the complex was first discovered in Victoria in 1954, two types of larvae were found, one characterised by the presence of a black longitudinal stripe along the dorsal side of the thorax and abdomen and the other coloured uniformly brown. There are small but constant morphological differences between these two types of larvae and between the pupae and adults arising from them. Examination of the type series of *A. stigmaticus* (one male and one female) showed that the mosquito with the striped larva belongs to this species. The form with brown larvae is described from adults of both sexes, pupae and larvae, as *A. pseudostigmaticus*, sp. n., the type series having been bred from larvae collected at Maroondah in the Hume Range in central Victoria in June 1956. Characters are given for distinguishing the adult, pupa and larva of *A. stigmaticus* from those of the new species. Both are homodynamic [**14** 123].

A. stigmaticus occurs in New South Wales as well as in Victoria, and two

larvae were collected near Hobart in Tasmania. It breeds in cold, clean, shaded water in mountain areas, such as stream-fed pools, the edges of slowly running creeks, pits in drying-out creeks and rock pools. Females have not been taken biting, but they oviposited after a meal of human blood in the laboratory. Only a few eggs hatched at laboratory temperature, but the remainder hatched immediately after the temperature of the water had been lowered to 10–13°C. [50–55·4°F.]. The distribution of *A. pseudostigmaticus* in eastern Australia extends from Victoria to southern Queensland. No females were taken biting. Larvae were taken in slowly running shallow water in a grassy roadside ditch at Baxter, in southern Victoria, in early spring as well as at the grassy edges of a clean-water swamp and in ground pools at the type locality. They have been collected all the year round in New South Wales where they occur in rock pools, weedy ground pools or seepage or overflow pools with clear or slightly muddy water. The breeding places are often shaded by trees; if they are exposed to the sun, larvae are most numerous among marginal grasses or in the shade of logs.

A. stigmaticus and *A. pseudostigmaticus* do not usually occur in the same localities, but at Maroondah, at an elevation of 1,500 ft., the larvae were found together in a shallow, grassy swamp in a clearing. The swamp was fed by a small stream that ran through a valley with dense vegetation during late autumn, winter and early spring and dried up in summer, leaving only a few deep pools in dense shade with water temperatures not exceeding 13–14°C. [55·4–57·2°F.]. *A. stigmaticus* bred in these, whereas the edges of the swamp, which is in full sun with water temperatures rising to 20–25°C. [68–77°F.], provided breeding places for *A. pseudostigmaticus*. However, the pools in the stream bed are flooded out after the autumn rains and larvae are carried down to the swamp, where in winter larvae of both species are temporarily found together. No intermediates were found among larvae or adults. The 50 per cent. lethal temperatures, with exposure for five minutes, were 37–37·5°C. [98·6–99·5°F.] for larvae of *A. stigmaticus* and 39°C. [102·2°F.] for those of *A. pseudostigmaticus*. Exposure for six hours at 33°C. [91·4°F.] was fatal to the former but not to the latter.

A. papuensis, sp. n., is described from bred adults of both sexes, pupae and larvae from Minj, New Guinea. In that locality, the larvae occurred in a semi-rock pool covered by vegetation; in a second locality, in the central Highlands, larvae were collected in a clear pool 6–8 in. deep beside a stream shaded by overhanging trees and having the water surface partly covered with vegetation and débris. Both these localities were in mountainous areas and situated at altitudes of about 6,000 ft. The morphology of the larva does not conform in all respects to that recorded for members of the complex in New Guinea by Soesilo [**22** 7], and it is probable that more species or subspecies belonging to the complex remain to be described from that area.

O'Gower (A. K.). **The Influence of the Surface on Oviposition by *Aëdes aegypti* (Linn.) (Diptera, Culicidae).**—*Proc. Linn. Soc. N. S. W.* **82** pt. 2 pp. 240–244, 13 refs. Sydney, 1957.

The following is largely based on the author's synopsis. In the experiments described, the selection by females of *Aëdes aegypti* (L.) of a water container as an oviposition site was influenced by the physical properties of its surface, namely its texture, its reflectance [*R.A.E.*, B **44** 61] and the presence or absence of free water. A rough surface was preferred to a smooth one, low reflectance to higher reflectance, and a free water surface

to a moist, porous surface. When the interaction of these properties was studied, a free water surface was preferred to a moist, porous surface of lower reflectance and rough texture, and a surface of low reflectance and smooth texture was preferred to a surface of high reflectance and rough texture. From these and similar experiments, it was concluded that a free water surface was always preferred as an oviposition site to a moist porous surface, irrespective of the texture or the reflectance of the latter.

Garnham (P. C. C.), Lainson (R.) & Cooper (W.). **The Tissue Stages and Sporogony of** *Plasmodium knowlesi*.—*Trans. R. Soc. trop. Med. Hyg.* **51** no. 5 pp. 384–396, 2 pls. (1 col.), 18 refs. London, 1957.

Hawking (F.), Mellanby (H.), Terry (R. J.) & Webber (W. A. F.). **Transmission of** *Plasmodium knowlesi* **by** *Anopheles stephensi*.—*T. c.* pp. 397–402, 1 fig., 10 refs.

It is recorded in the second of these papers that Edeson & Davey's virulent strain of *Plasmodium knowlesi* [*R.A.E.*, B **43** 41] was passaged four times through *Anopheles stephensi* List. and once through *A. maculipennis atroparvus* van Thiel and that a second strain from *Macaca irus* sent from Malaya in 1956 was passaged once through *A. stephensi*. The mosquitos were fed on infected rhesus monkeys [*Macaca mulatta*] and suspensions of them injected into fresh mosquitos, and after 11–13 days suspensions of the latter mosquitos were injected into fresh monkeys. Oocysts developed in the midgut of the mosquitos, but the sporozoites in the salivary glands were always scanty. The proportion of the mosquitos that became infected was variable, and this suggested that the infection in rhesus monkeys is transmissible to mosquitos only during a certain short period of its development, which it has so far not been possible to define, and it is recommended that successive batches of mosquitos should be allowed to feed on the monkeys as soon as the first gametocytes can be detected in their blood. The shortest pre-patent period observed in the monkeys was 6·8 days. There was no obvious change of virulence as a result of passage through the mosquitos.

The first paper includes an account of the passage of the two strains of *P. knowlesi* through *A. stephensi* and of the more recently isolated one through *A. aztecus* Hffm. The infection was transmitted to monkeys (*M. mulatta* and *M. irus*) by inoculation of suspensions of sporozoites derived from the midguts of mosquitos that contained rupturing oocysts or from such midguts and the salivary glands. The pre-patent period was 5½ days. Oocysts developed much more abundantly in *A. aztecus* than in *A. stephensi*, fewer degenerated, and sporozoites remained viable in the glands. It seems likely that man may contract malaria caused by *P. knowlesi* in nature, and the blood forms of the parasite could be mistaken for those of *P. malariae*. The failure of malaria caused by *P. knowlesi* to spread on a wide scale in Malaya may be explained by the restricted habitat of the sylvatic Anophelines, such as *A. baezai* Gater, that are presumed to be its natural vectors. The sporozoites found by Hodgkin in *A. baezai* [**45** 70] are suspected to have been of animal origin.

Shute (P. G.) & Maryon (M.). **A Study on the Infectivity of Patients to Mosquitoes in the early Stages of primary** *Plasmodium vivax* **Malaria (Madagascar Strain)**.—*Trans. R. Soc. trop. Med. Hyg.* **51** no. 5 pp. 403–410, 3 refs. London, 1957.

The following is based on the authors' summary. Successive batches of 100 laboratory-bred females of *Anopheles maculipennis atroparvus* van

Thiel were fed daily on each of 54 patients in the early stages of mosquito-induced infection with *Plasmodium vivax*, from the onset of symptoms or the appearance of parasites in the peripheral blood (whichever was first) until suppressive or curative treatment was given. Dissection of 40 mosquitos from each batch seven days after feeding showed that infection was acquired 2–7 days after the onset of fever or the appearance of parasites in the blood [*cf. R.A.E.*, B **42** 89], and that 5–100 per cent. of mosquitos that fed on the first day of infectivity became infected. Mosquitos acquired infection from 32 patients before gametocytes were detected in blood films from the latter, and from 22 patients on the first day on which male gametocytes were found. Maximum gametocyte density in primary untreated infections with *P. vivax* is reached on or about the tenth day, but the results showed that ripe gametocytes may be present in sufficient numbers to infect mosquitos as early as the third day and even, in one case, on the second. Few patients in areas in which *P. vivax* is endemic would be admitted to hospital or treated as early as the third day of a primary attack, even where medical services are good, and by this time they might have infected mosquitos. It is suggested that the chance of the success of malaria eradication and control schemes will be enhanced if drugs are given concurrently with the mosquito control operations.

Chwatt (L. J. Bruce-). **An unusual Epidemiology of Malaria in south-eastern Nigeria.**—*Trans. R. Soc. trop. Med. Hyg.* **51** no. 5 pp. 411–418, 1 map, 24 refs. London, 1957.

A survey of malaria epidemiology made in August 1956 in the Enugu Ezike area of south-eastern Nigeria showed that the local conditions were unusual in that *Anopheles gambiae* Giles had adapted its habits to breeding in considerable numbers in pots used for storing water [*cf. R.A.E.*, B **45** 131]. The area covers only about 100 sq. miles but is typical both of much of the Division in which it is situated and of the adjacent Division. It is on a plateau with light sandy soil, and there is no permanent, and little seasonal, surface water. The population density is about 300 per sq. mile, and water is brought from long distances and stored outside in large pots. The average density of females of *A. gambiae*, determined by spray-sheet collections, was found to be 2·8 per room per day, and there was a sporozite rate of 3·6 per cent. in 28 dissected. The resulting malaria is holoendemic [*cf.* **44** 191], with *Plasmodium falciparum* as the dominant parasite and *P. malariae* and *P. ovale* occurring with unusual frequency, mainly as mixed infections with *P. falciparum*. No other species of *Anopheles* was found, but many mosquitos of other genera were breeding in the water pots, which could be divided into three groups representing different micro-ecological conditions. *A. gambiae*, which was accompanied by *Aëdes apicoargenteus* (Theo.) in pots with clear water, bred almost alone in those containing water red with suspended colloidal clay, and vast numbers of Culicines (mainly *Culex* spp.) occurred in those with water polluted by organic matter.

The possibility of effecting control by the use of dieldrin pellets is discussed [*cf.* **45** 131]. The LD99's of dieldrin for fourth-instar larvae of *Anopheles gambiae*, *Aëdes aegypti* (L.) and *Culex pipiens fatigans* Wied., as estimated by various workers, are given. They are all below the solubility of dieldrin in water under tropical conditions (0·1 part per million), and the figures for first-instar larvae would be even lower [**46** 194]. As dieldrin made up in sand-cement pellets cannot form a precipitate, cannot be adsorbed and is very slowly released, there is little likelihood that

dieldrin-treated water would ever contain a dose approaching the toxic threshold for man.

Boorman (J. P. T.) & Porterfield (J. S.). **A small Outbreak of Yellow Fever in the Gold Coast.**—*Trans. R. Soc. trop. Med. Hyg.* **51** no. 5 pp. 439–449, 2 figs., 8 refs. London, 1957.

A small outbreak of yellow fever occurred in the Kintampo district of northern Ashanti, Ghana, in August and September 1955. Three cases were confirmed histologically, and yellow-fever virus was isolated from one non-fatal case. Two 24-hour mosquito catches with human bait [*R.A.E.*, B **42** 60] yielded 237 females of *Anopheles* spp., 39 of *Uranotaenia bilineata* Theo. (not known to bite man, but presumably attracted to light rather than the bait) 12 of *Culex* spp., three each of *Mansonia* (*Taeniorhynchus*) *uniformis* (Theo.) and *Aëdes africanus* (Theo.), two of *A. lutcocephalus* (Newst.) and one of *A. aegypti* (L.). The three females of *A. africanus* were all taken biting at ground level, and other catches showed this species to be widespread in the district, though present in small numbers. It is considered the most likely vector, but no virus isolations from mosquitos were made. The district is in the savannah zone. Water is abundant throughout the year and is not stored in pots. This and the scattered distribution of the cases make it very unlikely that *A. aegypti* was the vector. During a survey of mosquito breeding places, larvae of *A. simpsoni* (Theo.) were found in plant axils, but this species does not bite man in this area [*cf.* **45** 20, etc.]. Spray catches in huts yielded only three females of *Culex* sp. and one of *A. argenteopunctatus* (Theo.) in addition to large numbers of Anophelines.

Crosskey (R. W.). **Further Observations on Infection of** *Simulium damnosum* **with** *Onchocerca volvulus* **in Northern Nigeria.**—*Trans. R. Soc. trop. Med. Hyg.* **51** no. 6 pp. 541–548, 3 graphs, 5 refs. London, 1957.

Data are given on infection of *Simulium damnosum* Theo. with *Onchocerca volvulus* in two areas of Northern Nigeria, Abuja in Niger Province and Lokoja in Kabba Province. Females for dissection were caught alighting on fly-boys before they could bite, between 7.30 a.m. and 2 p.m. [*cf. R.A.E.*, B **46** 126]. Of 1,232 dissected at Abuja in September–October 1954 and June–October 1955, 5·4 per cent. were infected with *O. volvulus* and of these about a fifth were infective. Infectivity rates tended to be high when the fly population was low or moderate and low when the density, and therefore the biting rate, was highest. This relation was not shown in results obtained earlier in the Kudaru area (in Zaria Province), which had been analysed on a weekly basis [**43** 121], but analysis of these in half-monthly periods supported the view that fly infectivity and biting activity (in the wet season) may be inversely related. Some areas have a temporary decline in rainfall in August associated with a similar decline in density. At Kudaru, in 1953, there was such a decline in density, and this was associated with high infectivity in August; peaks in density, associated with low infectivity rates, occurred in July and September. At Lokoja, 783 females were dissected in July 1956 when the rains were just beginning, and 14·4 per cent. were found infected and 3·2 per cent. infective. There was evidence that infectivity increased progressively with increase of time since emergence (estimated by field observation). Infective worms were first seen in the thorax 7–8 days after

emergence and in the head after 9–10 days. The percentage of females harbouring head infections then rose until it reached over five 13–14 days after emergence, when observations had to be discontinued. On a second visit to Lokoja in September, when the Simuliid season was well established, a further 229 were dissected, of which only 3·1 per cent. were infected and 1·3 per cent. infective.

The data are discussed, and it is suggested that there are peaks in transmission at the beginning and end of the rains when Simuliid populations are building up and declining, as the higher biting rates of the height of the rains do not quite offset the reduced infectivity rate of that period. A peak in transmission in the early rains might be important in relation to exposure of the local population, as farming activity is at its height at this time and fishing, normally a dry-season pursuit, is still in progress. This may account for the heavy onchocercosis infection that has been reported in fishermen, which would otherwise be difficult to explain.

Since there is considerable day-to-day or month-to-month variation in infection rate, results from small samples of flies or from dissections carried out on only one or two days are not likely to give reliable comparisons between different seasons or between different foci; also, data derived from dissections of a population containing an unduly high proportion of young or newly emerged flies will not represent the general infection rate.

Lewis (D. J.). **A Method of recognizing individual nulliparous and parous Mosquitoes.**—*Trans. R. Soc. trop. Med. Hyg.* **51** no. 6 p. 561. London, 1957.

During recent studies on *Simulium damnosum* Theo. in Nigeria, it was found that parous females could be recognised by the presence of a corpus luteum in most of the ovarioles and of a small cord on many of the oocytes. This cord is a relic of the interfollicular tissue that formerly connected the larger of the existing oocytes with the earlier ones before these were ovulated. In females of *Anopheles gambiae* Giles, the corpora lutea were not always conspicuous, but distinct cords were found on many of the oocytes. If such cords exist in many species of mosquitos they will be useful for distinguishing parous individuals from those that have not laid eggs.

Pradhan (S.) & Mundkur (S. S.). **The Effect of Temperature on the Susceptibility of Mosquito** (*Culex fatigans*) **Larvae to DDT Suspensions.**—*Z. angew. Ent.* **40** pt. 3 pp. 371–379, 22 graphs, 5 refs. Hamburg, 1957. (With a Summary in German.)

In tests on the effects of differences in pretreatment and treatment temperatures on the action of DDT on the larvae of *Culex pipiens fatigans* Wied., four-day-old larvae, reared at about 27°C. [81·6°F.], were first exposed to temperatures of about 12, 20 or 30°C. [53·6, 68 or 86°F.] for 24 hours and then kept at each of these temperatures in suspensions of p,p′DDT at concentrations varying from 1 in 10 million to 1 in 1,000 million (and up to 1 in 10,000 million in the case of some pretreated at 12°C.). The following is based largely on the authors' summary of the results. When the pretreatment was about 12°C., mortality rose with increased treatment temperature at all concentrations. When the pretreatment temperature was about 20 or 30°C., there was a higher mortality at 12 than at 20°C. and, generally, a lower mortality at 20 than at 30°C. No reversal of these temperature coefficients could be detected with change in

concentration [*cf. R.A.E.*, B **39** 25]. In view of the results of earlier work by the senior author [*cf.* A **37** 408], it is provisionally concluded that when the larvae are pretreated at 12°C., they have, at the outset, limited activity, and thus pick up less insecticide, and low physiological resistance, but that, although both activity and resistance increase with the temperature, the effect of increased pick-up outweighs that of increased resistance. When, on the other hand, they are pretreated at 20 or 30°C., they are active at the outset and, when transferred to 12°C., remain active long enough to pick up so much insecticide that activity ceases to be the determining factor and resistance assumes the dominant rôle. The positive coefficient between 20 and 30°C., which was only slight in larvae pretreated at 30°C., results because, in this mosquito, resistance increased with temperature below 27°C.; above this point it decreased more rapidly than it had increased, so that at 30°C. it had fallen to very nearly the same level as at 20°C. This lowering of resistance at temperatures above the optimum appears to be enhanced by the sudden change of temperature from 20 to 30°C. experienced by the larvae pretreated at 20°C. and the positive temperature coefficient is therefore more clear-cut.

Clifford (P. A.). **Pesticide Residues in Fluid Market Milk.**—*Publ. Hlth Rep.* **72** no. 8 pp. 729–734, 10 refs. Washington, D.C., 1957.

More than 60 per cent. of 801 samples of market milk collected in a countrywide survey in the United States in the autumn of 1955 and examined by bioassay with flies [*Musca domestica* L.] gave evidence of the presence of chlorinated insecticides. Most of these were in trace amounts and were not identified specifically. The 160 samples giving the highest kills were examined by paper chromatography, and 169 by the Schechter-Haller method [*R.A.E.*, B **40** 173, etc.], mainly for confirmation. DDT, technical BHC, γ BHC (lindane), DDD, methoxy-DDT (methoxychlor) or DDE [1,1-di(p-chlorophenyl)-2,2-dichloroethylene] or more than one of these compounds were identified in many of the samples by paper chromatography. In the Schechter-Haller test, 89 of the 169 samples were positive, showing amounts of DDT and its decomposition products, metabolites or both ranging from a trace (0·03 part per million) to 1·46 p.p.m. However, the latter figure is not accurate for DDT because DDD, which interferes with the test, was also detected in the sample on the chromatogram. In almost all cases, the colorimetric and chromatographic results were in at least qualitative agreement. An *in vitro* cholinesterase-inhibition test failed to reveal the presence of any organic phosphorus insecticide. The source of the contamination with chlorinated compounds is not known; they may have resulted from residues on forage or from sprays applied to barns or to the cows themselves. A limited follow-up survey carried out during the winter of 1956–57 in four districts revealed little or no contamination of market milk with either DDT or BHC.

Kun (K. Y.), Sun (Y. C.), Ma (P. Y.) & Chang (J. T.). **Studies on Housefly Resistance to DDT. I. The Development of Resistance to DDT and BHC.** [*In Chinese.*]—*Acta ent. sin.* **8** no. 1 pp. 57–66, 1 fig., 6 graphs, 31 refs. [Peking] 1958. (With a Summary in English.)

The development of resistance to DDT and BHC in *Musca domestica vicina* Macq. was studied in the laboratory in China in 1952–56. The treatments to which the cultures were exposed in successive generations consisted in spraying the adults with acetone solutions of the insecticides,

rearing the larvae in treated media, or both. DDT was used at 1 and 3 per cent. in the solutions and at 80, 300 and 700 parts per million in the larval medium, and BHC was used at 0·01 and 0·03 per cent. and 10 p.p.m., respectively. Tolerance in each generation was tested by a horizontal spray technique and topical application, and LC50's (median lethal concentration) for sprays and the LD50's (median lethal dosage) for topical application were estimated. After selection for 40 generations in the first series and 24 generations in the second, resistance to DDT had increased 460 and 51 times, as compared with normal flies. Similarly, after selection for 30 and 24 generations, resistance to BHC had increased 60–80 and 58–60 times. Resistance to DDT increased gradually during the first 20 generations and more rapidly thereafter. Resistance to BHC increased gradually for eight generations and more rapidly for the next seven, after which it fluctuated. Spraying the adults was more effective than treating the larvae in increasing resistance, and the combined treatment was intermediate in effect. By all three methods, low concentrations of insecticide were more effective than high ones [*cf. R.A.E.*, B **47** 72], which suggested that selection was less important than adaptive changes. The DDT-resistant flies showed little increase in resistance to BHC, aldrin, dieldrin or toxaphene, but the BHC-resistant flies showed a greatly increased resistance to aldrin, dieldrin and toxaphene and comparatively high resistance to DDT.

A preliminary survey in several cities in northern China showed that the flies there had developed natural resistance to DDT; they were conspicuously resistant in 1956.

Chang (Chun) & others. **A preliminary Report of the Hibernation of common Species of Mosquitoes in Chungking.** [*In Chinese.*]—*Acta ent. sin.* **8** no. 1 pp. 85–92, 6 figs., 8 refs. [Peking] 1958. (With a Summary in English.)

Observations in Chungking in the winters of 1954–56 showed that *Anopheles hyrcanus* var. *sinensis* Wied. hibernates as adult females. No males were found. The mosquitos resumed activity and took blood in warm spells, but dissection of examples taken between November 1955 and April 1956 showed that although they were fertilised, their ovaries were undeveloped and they contained much fat. Hibernating females were most numerous in cowsheds and beneath bridges, but they also occurred in caves and tombs. The mosquitos disappeared from bedrooms when the atmospheric temperature fell below 10°C. [50°F.], and hibernating examples became less numerous in cowsheds and more numerous under bridges after the third week in December, when the temperature fell below 6°C. [42·8°F.], so that a migration to more favourable conditions occurs during hibernation.

Culex pipiens fatigans Wied. also hibernated in the adult stage, but larvae, mainly in the later instars, were present during the warm winter of 1955. *Armigeres obturbans* Wlk. overwintered in the larval stage, and *Aëdes albopictus* (Skuse) in the egg.

Young (M. D.) & Burgess (R. W.). **Effect of 25 Milligrams of Pyrimethamine on the Infectivity of** *Plasmodium vivax*, **St. Elizabeth Strain, to** *Anopheles quadrimaculatus*.—*Amer. J. trop. Med. Hyg.* **6** no. 5 pp. 805–807, 2 refs. Baltimore, Md., 1957.

The infectivity to females of *Anopheles quadrimaculatus* Say of four patients who had each received 25 mg. pyrimethamine (Daraprim) for the

suppression of malaria induced by infection with a strain of *Plasmodium vivax* was investigated in the United States. The presence of viable gametocytes had been demonstrated in all the patients 1–4 hours before they received the drug. Mosquitos were fed every four hours for the first 24 hours after treatment on one patient and at 24-hour intervals from the time of treatment at least until no more gametocytes could be demonstrated in the smears in all four. Parasites, including gametocytes, persisted for as long as seven days after treatment, but there appeared to be an immediate effect on the vitality of the gametocytes, as the number of mosquitos infected and the intensity of the infections began to decline almost at once. Oocysts seen 8 and 12 hours after administration of the drug were small and abnormal in appearance and did not mature into sporozoites. No oocysts were found 16 hours or more after treatment, and no sporozoites after eight or more hours.

Taylor (R. M.), Kingston (J. R.) & Rizk (F.). **A Note on Typhus in Egypt and the Sudan.**—*Amer. J. trop. Med. Hyg.* **6** no. 5 pp. 863–870, 1 graph, 8 refs. Baltimore, Md., 1957.

The incidence of typhus in Egypt began to decline rapidly in 1945 when DDT dusting of the population was introduced for the control of lice, *Pediculus humanus humanus* L. (*P. h. corporis* Deg.) [*R.A.E.*, B **37** 223], and cases have averaged less than 1 per 100,000 since 1947. To obtain information on the incidence and distribution of previous infection in the Nile Valley, sera collected in 1951–54 in Lower Egypt (including the Delta), Upper Egypt and the Sudan south of Khartoum were examined for complement-fixing antibodies against a typhus antigen; rodent sera from Alexandria and a village in the Delta were similarly examined. Positive reactions were obtained in the human sera from all three regions, but most occurred only in low dilutions of the serum, indicating that infection was not recent. The percentages of sera found positive in Lower Egypt, Upper Egypt and the southern Sudan were 19·3, 13·2 and 3·7, respectively, and the proportion increased with the age of the donors. By the use of specific antigens, 35 of 50 current infections were found to be of the epidemic and 15 of the murine type. All these recent infections occurred in or near Cairo or the Delta. Of 116 rodents (*Rattus rattus rattus*, *R. r. alexandrinus*, *R. norvegicus* and *Arvicanthis niloticus niloticus*) caught at Alexandria, 34 per cent. gave a positive complement-fixation reaction, the percentage not differing widely from species to species, but of 146 rodents (*R. r. rattus*, *R. norvegicus* and *Acomys cahirinus cahirinus*) caught in a village in the Delta, none was positive. It thus appears that both louse-borne and murine typhus still occur in Lower Egypt and that about two-thirds of the cases are of the louse-borne type. As a non-immune generation is growing up and resistance to DDT is developing in *P. h. humanus* [**41** 159; **44** 30; **47** 152–153], there is a danger that epidemics may develop if conditions become favourable.

Thomson (R. C. Muirhead-). **The Development of *Onchocerca volvulus* in Laboratory-reared *Simulium damnosum* Theobald.**—*Amer. J. trop. Med. Hyg.* **6** no. 5 pp. 912–913, 1 ref. Baltimore, Md., 1957.

Only one group of workers has hitherto induced uninfected, laboratory-reared females of *Simulium damnosum* Theo. to feed on man and maintained them long enough for ingested microfilariae of *Onchocerca volvulus* to reach the infective stage [*R.A.E.*, B **36** 148]. The author reports confirmatory work in Liberia in which several reared females fed in captivity and some were kept long enough for *Onchocerca* larvae to reach the infective stage.

The hungry females in 6-in. cylindrical feeding tubes were induced to feed through cotton netting on the legs of persons showing microfilariae of *Onchocerca* in their skin, and were subsequently kept in beakers and provided with filter paper and sterile sugar solution on cotton-wool. Three survived to show infective stages in the head and two others long enough for infective stages to appear in the abdomen. The infective forms were found after seven days in the hot, dry season and after nine days in the cooler rainy season, but may have been present in the latter case a day or two earlier.

Thomson (R. C. Muirhead-). **Laboratory Studies on the Reactions of *Simulium* Larvae to Insecticides. I. A Laboratory Method for Studying the Effects of Insecticide on *Simulium* Larvae.**—*Amer. J. trop. Med. Hyg.* **6** no. 5 pp. 920–925, 4 figs., 3 refs. Baltimore, Md., 1957. **II. The Reactions of *Simulium damnosum* Larvae to DDT.**—*T. c.* pp. 926–932, 2 graphs, 3 refs. **III. The Reactions of *Simulium damnosum* Larvae to Dieldrin.**—*T. c.* pp. 933–934, 2 refs.

The first of the following paragraphs is largely based on the author's summary of the first paper.

A technique is described for studying the reactions of *Simulium* larvae to insecticides in the laboratory, developed in Liberia with particular reference to *S. damnosum* Theo. By means of a constant stream of air bubbles directed against the inner walls of a large glass test jar, submerged larvae were induced to leave the vegetation on which they were fixed and to attach themselves to the inner wall of the jar at the point of maximum turbulence. In this position they could be counted and observed throughout an experiment. They were not handled, and mortality in untreated controls remained low for at least 48 hours after larvae had been collected from the field. By restricting collections to certain well-investigated sites it was possible in most cases to work with fairly pure cultures of various species. The water in the experimental jars was replaced with fresh stream water at the end of the exposure period, usually one hour, and again two or three times during the course of each experiment, and there was no need for a constant supply of untreated and unfiltered running water [*cf. R.A.E.*, B **42** 190]. If the change was effected quickly, there was no tendency for the larvae to become dislodged while exposed to the air.

The results of tests with DDT against *S. damnosum* by the above technique at 25–26°C. [77–78·8°F.] are given in the second paper. With exposure for one hour, DDT introduced into the water in acetone solution gave complete mortality of full-grown larvae in 24 hours at concentrations of 0·1 part per million or more and 99 per cent. mortality in 48 hours at 0·01 p.p.m. The LD50 was 0·005 p.p.m. on a 24-hour basis and 0·002 p.p.m. on a 48-hour basis. Exposure for one hour to 0·001 p.p.m. caused no appreciable mortality as compared with acetone alone after 24 hours, but the 48-hour mortality was nearly twice that of the control. The effects of exposure for five minutes to 0·01 p.p.m. appeared to be much the same as those of exposure for one hour to 0·001 p.p.m. Young larvae were much more susceptible and more rapidly affected than full-grown ones. An emulsion concentrate tested at 0·01 and 0·005 p.p.m. DDT with exposure for one hour was less effective than DDT in acetone, giving only 73 and 15 per cent. control, respectively, in 48 hours. The widely accepted standard for the control of *Simulium* larvae is 0·1 p.p.m. DDT with exposure periods up to one hour [*cf.* **44** 98], and although concentrations of 1 p.p.m. or more have been used against *S. damnosum*, it is stated that they have been recognised to be unnecessarily high [but *cf.* **47** 25].

Similar tests with dieldrin against *S. damnosum* are described in the third paper. Exposure to dieldrin from an emulsion concentrate for one hour gave complete mortality of full-grown larvae in 24 hours at concentrations down to 0·001 p.p.m., but effectiveness fell off rapidly at concentrations below this. There was 24 and 56 per cent. kill in 24 and 48 hours, respectively, at 0·0005 p.p.m., but no appreciable effect at 0·0002 p.p.m. Recrystallised dieldrin in acetone was less effective than the concentrate, giving only 60 and 68 per cent. kill in 24 and 48 hours, respectively, at 0·001 p.p.m.

Rahm (U.). **Zur Bedeutung des Duftes und des Schweisses bei der Attraktion von *Aedes aegypti* durch den Menschen.** [On the Significance of Odour and Sweat in the Attraction of *A. aegypti* to Man.]—*Acta trop.* **14** no. 3 pp. 208–217, 7 figs., 17 refs. Basle, 1957. (With Summaries in French & English.)

A description is given of a modification of an apparatus used by the author in earlier work [*R.A.E.*, B **46** 132], devised so that the attractiveness to *Aëdes aegypti* (L.) of an artificial hand (a bottle kept at a temperature of 35°C. [95°F.] and covered with a wet cloth) combined with the volatile substances (odour) emitted by the human hand or with sweat could be compared with that of the human or artificial hand alone. An airstream entering the cage containing the mosquitos passes over the palm of a human hand (to give odour only), the artificial hand or both or the artificial hand covered with a cloth moistened with sweat obtained from a hand [*cf.* **45** 110]. With the airstream at 35°C. the artificial hand alone was not very attractive and the addition of human sweat (the amount of which was determined by the time taken to produce it, and not by volume) seldom did more than double its attractiveness and often had hardly any effect, but the addition of the odour of the human hand (without sweat) quadrupled its attractiveness and made it as attractive as a normal hand. With an airstream temperature of 26°C. [78·8°F.] the odour of a hand was only very slightly attractive; additional heat or moisture increased its attractiveness, sometimes doubling it; and odour, heat and moisture combined had the strongest attraction, which was generally greater than the sum of the attractiveness of odour and heat and that of odour and moisture. Comparative tests, without an airstream, between human hands, artificial hands and artificial hands with the addition of sweat confirmed these results.

Sandosham (A. A.). **Malariology with special Reference to Malaya.**—$8\frac{3}{4} \times 5\frac{3}{4}$ in., xix + 327 pp., 20 pls. (12 col.), 33 figs., text illus., 41 refs. London, Oxford Univ. Pr. for Univ. Malaya Pr., 1959. Price £1 15*s*.

This is essentially a text-book for undergraduate medical students and post-graduate students taking a diploma in Public Health in Malaya, where malaria is still a major problem in spite of the introduction of modern insecticides and prophylactic drugs. The introductory chapter includes, for the benefit of foreign students and newcomers to the country, brief notes on the people, climate, topography, vegetation, etc. of Malaya and information on the history of malaria in that country. This is followed by a chapter summarising some basic zoological and haematological information and others dealing with the natural history of malaria (classification and life-history of malaria parasites, morphology of *Plasmodium falciparum*, *P. vivax* and *P. malariae*, the kinds of malaria they cause, clinical phenomena, the relation of the disease to climate and topography and endemicity and epidemicity), the natural history of Anophelines, the making of malaria and Anopheline surveys and the control of Anophelines and prevention and

control of malaria. Anopheline control measures dealt with include drainage, application of oils and other larvicides, anti-adult spraying, naturalistic measures including the deliberate pollution of water and the control of its movement, the use of natural enemies, and deviation by animals, and supplementary measures such as the use of protective clothing, mosquito nets and repellents and the screening of houses. Brief data on microscopic, haematological and entomological techniques, an aid to the identification of malaria parasites and pictorial keys to the larvae and females of the common Malayan Anophelines are appended, and there is also a glossary.

The chapter on Anophelines, which occupies more than 100 pages, includes information on their geographical distribution, morphology, physiology and bionomics, and lists of the species and subspecies of *Anopheles* recorded as occurring in the Malay Peninsula and of the species known to be vectors there, with summaries of the results from dissections of *Anopheles* that have been experimentally infected and of those that have been recently caught, and general notes on their distribution in ecological zones, their seasonal prevalence and the effect of agricultural and other practices on them. Each of the Malayan vector species is briefly described, and notes are given on its prevalence, bionomics, vector status and control. Brief descriptions, generally accompanied by indications of prevalence and bionomics and sometimes of their possible relation to malaria are also given for the species not known to be vectors and for some species of very local, slight or incompletely determined significance. These are arranged alphabetically for easy reference. They include a form of *A. hyrcanus* (Pall.) *sens. lat.* that is described from the female and larva as *A. lesteri* subsp. *paraliae*, n. It occurs in coastal areas of Malaya, where it was recorded as *lesteri* Baisas & Hu by Reid [*R.A.E.*, B **41** 117] and in Borneo, where it was described by Colless [**37** 145] as a subspecies of *A. hyrcanus* near *sinensis* Wied. It has been found infected with mature larvae of *Wuchereria malayi* [*cf.* **41** 118] in Penang and Province Wellesley, and has occasionally attacked man in the shade when disturbed in its daytime resting places, but rarely enters houses or window-trap huts with narrow louvered entrances, unless the hut contains animals, such as calf or goat, instead of man. It breeds in shady pools and ditches containing slightly brackish water. Larvae occur freely in water containing 18 per cent. sea-water and have been found on occasion in water containing 70–80 per cent. sea-water.

STARKOFF (O.). **Ixodoidea d'Italia. Studio monografico.** [Ixodoidea of Italy. A monographic Study.]—$8\frac{3}{4} \times 5\frac{3}{4}$ in., 384 [+1] pp., 34 pls., 22 figs., 1 fldg. map, 30 pp. refs. Rome, "Il Pensiero sci." Edit., 1958. Price *L.*4,500.

This review of information on the ticks that occur in Italy (including Sicily and Sardinia) is based on the literature and on extensive observations by the author over a period of 20 years. About one-third of the information on hosts and regional distribution is derived from the literature and two-thirds from personal observation. The development of knowledge on ticks, with particular reference to Italy, terms used in morphological descriptions and notes on general morphology and bionomics are the subjects of introductory sections. The main part of the book, occupying some 250 pages, consists of a review of the six Argasids and 18 Ixodids known to occur in Italy. Keys are given to the adults of the various species (of both sexes if known), and for each species the adults are described, synonyms are noted, the literature on its occurrence in Italy is reviewed, and the author's observations are recorded. Pathogenic importance, if any, and distribution outside Italy are very briefly indicated.

Summaries are also included of the distribution in Italy and the host groups of the different species, the classes of hosts parasitised by the various stages and the seasonal occurrence of the stages (mostly on the basis of data obtained in central Italy), together with lists of the ticks showing the regions and hosts from which each has been recorded, of the hosts showing the ticks recorded from them, and of ticks found without hosts. The records that are based on personal observation are indicated in each case. The book also contains a list of names that should be dropped from lists of Italian ticks, as they are synonyms, invalid or based on doubtful or erroneous identifications, and an extensive bibliography.

Nelson (W. A.). **Transfer of Sheep Keds, *Melophagus ovinus* (L.), from Ewes to their Lambs.**—*Nature* **181** no. 4601 pp. 56–57, 4 refs. London, 1958.

It is usually stated that sheep keds (*Melophagus ovinus* (L.)), presumably of all ages, are transferred from ewes to their lambs [*cf. R.A.E.*, B **38** 80], and much of the decline in ked populations on ewes in spring and summer has been attributed to this. It was found in Alberta, however, that only newly emerged adult keds are transferred. No pupae appeared on lambs until the latter were 4–6 weeks old, and all keds seen on lambs up to four weeks old were small ones. Females are thought to deposit their first offspring 14–30 days after emergence [*cf.* **30** 31; **38** 80]. Examination of ten lambs showed 11·6 ± 6·53 adult keds and no pupae on lambs two weeks old, 43·3 ± 23·2 keds and 1·5 ± 1·8 pupae on lambs four weeks old and 137·3 ± 59·84 keds and 25·5 ± 18·34 pupae on lambs six weeks old. The older keds on the ewes gradually die off as a result of infection with *Trypanosoma melophagium* [*cf.* **45** 53].

Gregson (J. D.). **Host Susceptibility to Paralysis by the Tick *Dermacentor andersoni* Stiles (Acarina: Ixodidae).**—*Canad. Ent.* **90** no. 7 pp. 421–424, 5 refs. Ottawa, 1958.

Observations on various mammals infested with adults of *Dermacentor andersoni* Stiles in areas of British Columbia in which tick paralysis occurs showed that large wild animals appear not to be subject to it, although one case has been recorded in a buffalo (*Bison*) in Montana. Large domestic animals (cattle, horses, sheep and dogs) are, on the other hand, relatively susceptible, and man is particularly so. Examination of the histories of about 250 cases in man in British Columbia, 28 of which were fatal, showed that only one female tick was involved in each instance. Laboratory rabbits, guineapigs and mice all appear to be highly resistant, no cases being observed in them, but marmots (*Marmota flaviventris avara*) and ground squirrels (*Citellus columbianus*) were readily paralysed and killed by small numbers of female ticks. Paralysis set in on about the fifth day of attachment, and death followed in 12–24 hours. When the ticks were removed, recovery was slow and uncertain. Transfer of partly engorged ticks to two fresh marmots induced paralysis in the latter in only 17 and 36 hours, but a new batch of ticks on animals that had recently recovered caused paralysis in the usual time, and it is suggested that the production and timing of paralysis in a susceptible animal depend on the condition of the feeding tick and not on that of the host. Paralysis was also produced in a marmot by subcutaneous injection of the crushed salivary glands of feeding ticks, but not of 0·2 cc. of the secretions from partly fed ticks [*cf. R.A.E.*, B **46** 104–105].

Gjullin (C. M.) & Isaak (L. W.). **Present Status of Mosquito Resistance to Insecticides in the San Joaquin Valley in California.**—*Mosq. News* **17** no. 2 pp. 67–70, 7 refs. Albany, N.Y., 1957.

By 1951, moderate resistance to chlorinated-hydrocarbon insecticides had developed in mosquito larvae in the northern part of the San Joaquin Valley of California, and high resistance with complete failure of control in the south [*cf. R.A.E.*, B **41** 47]. Organophosphorus compounds had to be adopted in the latter part of the area, and EPN [O-ethyl O-p-nitrophenyl phenylphosphonothioate], parathion and malathion have been used there since; in the north, resistance has increased, and organophosphorus compounds have been used in the last two or three years. Results are given of tests on resistance to organophosphorus insecticides and DDT made in 1956 in Fresno County, towards the north of the area, and Kern County, in the south of it. Early fourth-instar larvae were collected inside and outside the treated areas and were tested for resistance in batches of 20 in acetone-water suspensions of the insecticides; adults bred from the larvae were tested by exposure for 90 minutes in batches of 10–15 on deposits from acetone solutions.

It is concluded that the use of malathion in Fresno County during 1954–56 caused resistance to develop in both larvae and adults of *Culex tarsalis* Coq. The LD90 for larvae from treated areas was more than 30 times as much as for the larvae from untreated areas, and the use of malathion as a larvicide against *C. tarsalis* was no longer practicable. Adult females of *C. tarsalis* from treated parts of Fresno County were 100 times as resistant as those from untreated parts of Kern County. Malathion was still effective against *Aëdes nigromaculis* (Ludl.), however, in both counties. In the treated parts of Fresno County, resistance of the larvae of both species to DDT appeared to be 2–3 times greater than in 1951. Parathion, which had not been used in Fresno County, was effective against larvae of both species from malathion-treated localities. Larvae of neither species showed resistance to parathion in the treated parts of Kern County, although EPN and parathion had been used there consistently since 1951, nor was there any cross-resistance to malathion. This indicates that resistance to parathion may develop more slowly or not at all.

Singh (K. R. P.) & Micks (D. W.). **The Effects of Surface Tension on Mosquito Development.**—*Mosq. News* **17** no. 2 pp. 70–73, 1 graph, 3 refs. Albany, N.Y., 1957.

The effects of various surface tensions of the water between 31 and 78 dynes per cm. on pupal development and adult emergence were studied in six strains of mosquitos (*Culex pipiens pipiens* L., *C. p. molestus* Forsk., *C. p. fatigans* Wied., *Aëdes aegypti* (L.) and *Anopheles quadrimaculatus* Say, all from laboratory colonies, and *C. p. fatigans* of a strain collected from a sewage drainage ditch in Texas). Tests were made at 25°C. [77°F.], at which temperature the normal surface tension of water is 72 dynes per cm.; Tween 80 was used to lower it, and magnesium chloride to raise it. All pupae died at 31 and 78 dynes per cm., nearly all at 41, and most pupae of all species except *Aëdes aegypti* at 76. No adults completed emergence at 41. Some adults of all strains except *Anopheles quadrimaculatus* did so at 45, and some of all except *C. p. molestus* at 76, but laboratory *fatigans* and *Aëdes aegypti* were the only strains showing more than 50 per cent. emergence at 45 and 76, respectively. Pupal mortality was generally very low at 53 and 72 and fairly low at 73·5. About 80 per cent. or more of all strains of *Culex*, but only 38 and 36 per cent. of *A. aegypti* and *Anopheles quadrimaculatus*, emerged successfully at 53. At 72, there was complete

emergence of both strains of *C. p. fatigans*, *C. p. molestus* and *Aëdes aegypti* and 92 and 82 per cent. emergence of *C. p. pipiens* and *Anopheles quadrimaculatus*. At 73·5, successful emergence of *Aëdes aegypti* was still very high (96 per cent.), but all other strains were adversely affected, particularly *C. p. molestus* and *Anopheles quadrimaculatus*, of which only 53 and 58 per cent. emerged successfully.

The differences in the reactions of mosquitos of the three genera to surface tension seem to be in accordance with their natural habitats, the species of *Culex*, which generally breed in polluted water withstanding lower surface tensions than *Aëdes* and *Anopheles*, which breed in clean water.

ZIEGLER (L. W.). **A practical, long-lasting Emulsion Type Larvicide.**—*Mosq. News* **17** no. 2 pp. 74–76. Albany, N.Y., 1957.

Most insecticidal emulsion concentrates are heavier than water, and the emulsions break soon after dilution. Frequent agitation is therefore needed in the spray tank, and the active ingredients are lost in the mud and débris on the bottom of a mosquito breeding area soon after application. Stability is determined by the character of the emulsifier, the size of the oil globules and the specific gravity of the oil. In this paper, a tested, practical method is described of making a stable emulsion, with prolonged active life, by adjustment of the specific gravity. If the globules have the same specific gravity as water, they will neither rise nor sink. Perfect balance is, however, difficult to obtain. Moreover, if the oil phase with the insecticide is kept slightly lighter than water, it will not so readily settle should it be made slightly heavier than was intended, and the larvicide will tend to remain nearer the surface. A specific gravity of 0·990–0·995 is recommended. To obtain it, a DDT concentrate (about 30 per cent. DDT in an aromatic petroleum solvent), which has a specific gravity greater than 1, is mixed with a suitable emulsifier, and fuel oil is added by trial and error to reduce the specific gravity to the desired level. Approximate proportions for solutions of three different specific gravities are given, but use of precision-type hydrometers for testing is recommended. DDT in the type of emulsified solution described gave satisfactory control of mosquito larvae in a water-filled sand pit in New York State for about three weeks at about 1 : 1,500,000 by weight, which is a relatively weak dose.

MURRAY (W. S.). **Investigations on the Bionomics of *Culicoides obsoletus* (Meigen) and other Biting Midges at Mount Solon, Virginia.**—*Mosq. News* **17** no. 2 pp. 77–82, 6 figs., 13 refs. Albany, N.Y., 1957.

The following is almost entirely based on the author's summary. During the summer of 1951, the bionomics and ecology of *Culicoides* spp. were studied in the area round Mount Solon, Virginia, where the midges cause severe annoyance. Three light-traps were operated on 51 nights from 16th June to 6th September, mainly in and near a camp site at an altitude of 1,572–1,620 ft. Catches of over 1,000 midges were made in at least one trap on 28 nights, and catches of 7,000–10,000 were not unusual; the maximum was over 45,000. *C. obsoletus* (Mg.) comprised 95 per cent. of the total catches, but 14 other species were represented. *C. guttipennis* (Coq.) and *C. villosipennis* Root & Hffm. were taken in forest at high altitude. *C. obsoletus*, *C. arboricola* Root & Hffm. and *C. travisi* Vargas in or near forest and *C. stellifer* (Coq.), *C. crepuscularis* Mall., *C. venustus* Hffm., *C. variipennis* (Coq.) and *C. haematopotus* Mall. in lowland fields and pastures. *C. biguttatus* (Coq.) was recovered from nearly all forest and lowland habitats.

An analysis of catches made in one trap on four nights in July and August showed that on two of the nights, the numbers of *C. obsoletus* caught from 11 p.m. to 5 a.m. were much greater than those caught from 8 p.m. to 11 p.m. Other species also showed increased activity during the late night and early morning hours. Routine biting counts made three times a week on arms exposed for 15 minutes showed that *C. obsoletus*, *C. biguttatus* and *C. guttipennis* were the chief night biters and that *C. stellifer* bit occasionally during the day. There were two general increases in numbers of *Culicoides* during the study, one from mid-June to mid-July and the other from late July to mid-August. Several species appeared in smaller numbers during late August and early September. To determine breeding areas, pupae were reared from soil samples (mud, sand and humus) and emerging adults were trapped in the areas indicated by the results. All species needed moisture and some shade, and most preferred sand rich in humus. *C. obsoletus* was taken in numbers from sand, compost heaps of leaves and tree holes.

Tarshis (I. B.). **An Apparatus and Technique for the continuous Anesthetization of haematophagous Insects with Dry Ice.**—*Mosq. News* **17** no. 2 pp. 83–86, 3 figs., 7 refs. Albany, N.Y., 1957.

A description is given of an anaesthetising chamber, using carbon dioxide, designed to facilitate the separation of fed from unfed blood-sucking arthropods. The chamber consists of a shallow, topless, rectangular stainless-steel box with a glass bottom. The sides are formed by a tube of rectangular cross-section, through holes in which the carbon dioxide enters. The tube is mounted on the base of the chamber so as to leave a horizontal flange, which slips into the grooves normally used to hold the glass stage on a dissecting microscope. The carbon dioxide is obtained by piping off the gas that forms as crushed dry ice in a reagent bottle evaporates at room temperature. Its free flow is indicated by the bubbles produced during its passage through a second reagent bottle that is half filled with water. From this it passes into the tube through a needle valve, and thence into the chamber. Light transmitted through the glass floor from below illuminates the digestive tract of the arthropods, so that even a very small amount of blood within it can be detected. The technique has been used successfully with fleas (*Xenopsylla cheopis* (Roths.)) and mosquitos (*Aëdes aegypti* (L.)). Fleas can be anaesthetised with carbon dioxide for several hours and mosquitos for two hours without lethal effects.

Gentry (J. W.) & Hubert (A. A.). **Resistance of *Culex quinquefasciatus* to Chlorinated Hydrocarbons on Okinawa.**—*Mosq. News* **17** no. 2 pp. 92–93, 3 refs. Albany, N.Y., 1957.

On Okinawa, DDT has been used for insect control since its adoption during the Second World War, and chlordane has recently been used also. DDT has been applied both as a house spray and as a larvicide in mosquito control programmes. Signs of resistance in mosquitos were first noticed in the field in 1954, and preliminary laboratory tests early in 1955 suggested that larvae of *Culex pipiens fatigans* Wied. (*quinquefasciatus*, auct.) had become resistant to both DDT and chlordane. Tests were therefore made during the winter of 1955–56 to determine the effectiveness of these insecticides and also of dieldrin, γ BHC (lindane) and malathion against larvae of this mosquito collected in southern Okinawa. The results indicated that the larvae had become extremely resistant to the chlorinated-hydrocarbon insecticides but that they had little or no resistance to malathion; the LD50's

for DDT, chlordane, dieldrin, γ BHC and malathion, with exposure for 48 hours, averaged 0·6, 1·2, 0·2, 0·2 and 0·01 parts per million, respectively.

Bonnet (D. D.) & Mukaida (T.). **A Copepod predacious on Mosquito Larvae.**— *Mosq. News* **17** no. 2 pp. 99–100, 2 refs. Albany, N.Y., 1957.

High mortality among the first- and second-instar larvae of *Toxorhynchites brevipalpis* Theo. in a laboratory colony in Hawaii was attributed to improper feeding [*R.A.E.*, B **41** 78]. In efforts to improve the diet, various organisms were added to it. These included adults of the Copepod, *Mesocyclops obsoletus*, but these attacked the *Toxorhynchites* larvae and killed many in rapid succession. Sometimes two or more Copepods would simultaneously attack and kill a third- or fourth-instar larva. One was found able to destroy 15–20 second-instar *Aëdes* larvae in 24 hours. *M. obsoletus* occurs commonly in pools, streams and swamps in Hawaii and undoubtedly destroys young larvae of *Culex pipiens fatigans* Wied. (*quinquefasciatus*, auct.), but its significance in the control of this mosquito is thought to be slight. It has not been found in the tree holes, water-holding plants or other containers in which *Aëdes albopictus* (Skuse) breeds, so that it cannot be a factor in the control of this species, against which *T. brevipalpis* was introduced, but it preys actively on mosquito larvae in laboratory cultures.

Weidhaas (D. E.). **Laboratory Study of the Release of some organic Phosphorus Insecticides into Water from Granular Formulations.**— *Mosq. News* **17** no. 3 pp. 168–172, 7 refs. Albany, N.Y., 1957.

The release of parathion into water from granular formulations with five types of carriers, an attapulgite, a montmorillonite (bentonite), vermiculite, a diatomite and a pyrophyllite, was investigated in the laboratory at Orlando, Florida. Limited studies were also made with Chlorthion [O,O-dimethyl O-3-chloro-4-nitrophenyl phosphorothioate] and EPN [O-ethyl O-p-nitrophenyl phenylphosphonothioate]. In most cases, the carriers were impregnated with an acetone solution of the insecticide, but as acetone swelled and dispersed montmorillonite granules, benzene was substituted when montmorillonite was the carrier. In some tests, other solvents were used, with or without a wetting agent. When distilled water in jars or beakers was treated with attapulgite granules containing 1 per cent. parathion to give 20 parts parathion per million, sampling after 24 hours showed a uniform distribution of the toxicant between the top and ¼ inch from the bottom, but the concentration in the filtrate from the bottom ¼ inch was about twice as great. Increasing the amount of 1 per cent. granules added to equal volumes of water increased the concentration of toxicant present, but decreased the percentage of the total released.

In quantities to give 1 or 20 p.p.m., granules containing 1 per cent. parathion released 2–5 times as much parathion in 24 hours as did those containing 10 per cent. when the carrier was attapulgite, vermiculite or diatomite and the water was distilled or salty, but there was little difference when the carrier was montmorillonite and the water was distilled. The results with 20 p.p.m. showed that the differences were reduced with the passage of time. Pyrophyllite could be used only as a 1 per cent. formulation. Granules with 1 per cent. parathion on vermiculite tended to give the highest initial release rate. The rates of release from the two montmorillonite formulations were generally somewhat lower than those from the other 1 per cent. formulations when the potential dosage was 20 p.p.m. but about the same or higher when it was 1 p.p.m. The parathion already dispersed in the water had a tendency to reduce the release rate. In these tests, 30–50 per

cent. of the parathion was not released in nine days, the release from granules of montmorillonite impregnated with 1 per cent. parathion being the lowest. To determine whether adsorption was affecting the amount released, 1 g. of each of the granular carriers was added to 50 ml. water containing parathion at 15·5 p.p.m. and shaken. Montmorillonite granules dispersed to form an almost colloidal suspension, and 27 per cent. of the parathion was adsorbed in 24 hours; the other four carriers adsorbed only 3–10 per cent. Slightly less parathion was released in 24 hours into marsh salt water than into distilled water from all formulations tested except the 10 per cent. concentration on montmorillonite. This showed such a considerable decrease that the concentration produced was about the same as that provided by the other carriers. The decrease is attributed to the fact that the montmorillonite granules did not swell and disperse in salt water as much as they did in distilled water.

The addition of 2 per cent. kerosene or Triton X-100, or of 1 per cent. of each of these, had no effect on the amount of parathion released from attapulgite, but the presence of Velsicol AR-60 or soil with diatomite granules reduced the amount of parathion found in the water. In a comparison of the rates of release of parathion, Chlorthion and EPN, granules of attapulgite, vermiculite and diatomite with 1 per cent. parathion or Chlorthion released the toxicant more rapidly than did those with 10 per cent., the amounts released being about the same for the two toxicants. The amounts of EPN released were insufficient for analysis. Both formulations on montmorillonite released about the same amount of toxicant in 8 hours, the amount being similar to or larger than that released from 1 per cent. formulations on the other carriers. Almost total release of parathion was obtained in 48 hours from attapulgite with 1 per cent. toxicant and from montmorillonite with 1 or 10 per cent., but not from the other formulations.

Mathis (W.) & Schoof (H. F.). **Studies with Organophosphorus Compounds in the Control of *Psorophora* Larvae in Mississippi Rice Fields.**—*Mosq. News* **17** no. 3 pp. 173–179, 3 figs., 6 refs. Albany, N.Y., 1957.

In laboratory tests in 1955, Chlorthion [O,O-dimethyl O-3-chloro-4-nitrophenyl phosphorothioate], malathion, DDVP [dimethyl 2,2-dichlorovinyl phosphate] and Dipterex [dimethyl 2,2,2-trichloro-1-hydroxyethylphosphonate] at 0·0125, 0·1, 0·1 and 0·5 parts per million, respectively, in acetone-water suspension gave complete mortality of third- or fourth-instar larvae of *Psorophora confinnis* (Lynch-Arrib.) exposed for 24 hours. Well or stream water was used. Chlorthion introduced as an emulsion into the irrigation water of rice-fields 8 and 3 acres in area at 0·025 and 0·074 p.p.m., respectively, failed to give satisfactory control of larvae of *P. confinnis* in 1955. In field tests in 1956, parathion, in the form of a solubilised concentrate containing 1 part parathion and 4 parts Triton X-100 [*cf. R.A.E.*, B **45** 4], and Dipterex (soluble powder) were injected directly into irrigation water [*cf.* **45** 193] of 94- and 28-acre fields at 0·02 and 0·25 p.p.m., respectively. Control of larvae was satisfactory only near the point of entrance of the water into the fields. The regular irrigation practices of the Mississippi Delta, in which the soil is allowed to dry between floodings, were not altered in any way in these tests. The failure of the materials under field conditions, which contrasts with the findings of Gahan & Noe in Arkansas [**45** 4], was believed to be caused largely by the detoxification of the treated irrigation water which occurs as it percolates through the dry soil of the dikes. In Arkansas, the test plots had the irrigation canals at right angles to most of the levees, whereas in the Mississippi tests, the water usually entered the highest terrace and moved through the field to the lowest.

In small-plot tests of granular formulations in 1955, Chlorthion, malathion, Dipterex and DDVP on bentonite and malathion on tobacco stems failed to give satisfactory larval control when applied as pre-flood treatments each at 0·2, 0·4 and 0·5 lb. per acre as did Chlorthion and malathion at 0·75 lb. The same formulation of Chlorthion applied as a post-flood treatment at 0·2 lb. per acre gave essentially complete control in 24 hours. It is assumed that, in the pre-flood applications, the first water that entered the field carried the insecticide into the soil, so that the toxicant was removed before sufficient water was present to flood the plot and allow the mosquito eggs to hatch.

Davis (A. N.) & Gahan (J. B.). **Field Tests with four Phosphorus Insecticides against Salt-marsh Mosquitoes in Florida.**—*Mosq. News* **17** no. 3 pp. 180–183, 2 refs. Albany, N.Y., 1957.

Field tests were carried out in Florida in 1956 to evaluate aerial application of four organophosphorus compounds for the control of salt-marsh mosquitos (*Aëdes taeniorhynchus* (Wied.) and *A. sollicitans* (Wlk.)) resistant to chlorinated hydrocarbons [*cf. R.A.E.*, B **39** 58]. Oil sprays of malathion and Chlorthion [O,O-dimethyl O-3-chloro-4-nitrophenyl phosphorothioate] and a water solution of Dipterex [dimethyl 2,2,2-trichloro-1-hydroxyethylphosphonate] were tested against the adults. Chlorthion was dissolved in cyclohexanone (1:4) before being mixed with fuel oil. Malathion gave more than 90 per cent. control after six hours at 0·1 lb. per acre in *Citrus* groves or open salt-marsh areas, but only 64 per cent. control at 0·25 lb. in mangrove marsh. Chlorthion gave 82–99 per cent. control in *Citrus* groves but only 56 per cent. in mangrove marsh at 0·25 lb. and 74 and 94 per cent. in two tests in open marsh at 0·1 lb. Both were ineffective in wooded areas. Dipterex gave 77 and 96 per cent. control at 0·5 lb. in two tests in *Citrus* groves, but was less effective at 0·25 lb. in them or at 0·1 lb. in open marsh. *A. sollicitans* predominated in open marshes and *A. taeniorhynchus* in all other habitats. Cover was more dense in the wooded areas and mangrove marshes than in the *Citrus* groves.

In tests against mixed populations of fourth-instar larvae of the two species in open salt-marshes, oil solutions of Bayer 21/199 [O,O-diethyl O-3-chloro-4-methyl-7-coumarinyl phosphorothioate], Chlorthion, malathion and Dipterex gave more than 89 per cent. control in 24 hours at 0·25 lb. per acre. Chlorthion and malathion were also tested at 0·1 lb. and were comparatively ineffective at that dosage. Chlorthion and Bayer 21/199 were dissolved in trichloroethylene at 1:5 and 1:9, respectively, and Dipterex in cyclohexanone at 1:4, before solution in fuel oil. On attapulgite granules, Bayer 21/199 gave at least 97–99 per cent. control of mixed populations of fourth-instar larvae in salt-marshes in 24 hours at 0·1 lb. per acre, and 99 per cent. at 0·05 lb. Chlorthion and malathion gave 97–100 and 64–99 per cent. control, respectively, at 0·5 lb. per acre and the former gave 79 per cent. at 0·2 lb. and the latter 81 and 99 per cent. at 0·25 lb. Dipterex gave more than 99 per cent. control at 0·75 lb. and 0 and 79 per cent. at 0·5 lb. per acre. The standard, γ BHC at 0·1 lb., gave only 45 per cent. control.

Davis (A. N.), Beidler (E. J.) & Ringdahl (J. P.). **Aerial Spray Tests with Malathion, Pyrethrum, and Allethrin against *Aëdes taeniorhynchus* in Florida.**—*Mosq. News* **17** no. 3 pp. 184–185. 7 refs. Albany, N.Y., 1957.

Pyrethrins have not been used in the open on a large scale in sprays for mosquito control because they are less economical than some other

insecticides. However, as some populations are resistant to chlorinated hydrocarbons and resistance to the organophosphorus compounds may develop, solutions in fuel oil of 0·1 per cent. pyrethrins and 0·2 per cent. allethrin, both combined with 0·5 per cent. piperonyl butoxide, and of 2·86 per cent. malathion were compared as sprays against adults of *Aëdes taeniorhynchus* (Wied.) in Florida in 1956. The sprays were applied from aircraft at 1 U.S. gal. per acre to wooded areas where trees and undergrowth formed a canopy that complicated control. Three plots were sprayed, one with each insecticide, between dawn and 7.20 a.m. on 7th and 30th August and 5th September, and each plot received each material once to minimise the effect of difference between the plots. The flight-lines were across the wind. The malathion sprays were the most effective. Six hours after spraying with malathion there was an average reduction of 92 per cent. in mosquitos landing on observers, compared with reductions of 62 and 56 per cent. after the applications of allethrin and pyrethrins, respectively. A rapid infiltration of mosquitos reduced the control with all the insecticides after 24 hours, generally to negligible proportions.

Rogers (A. J.), Beidler (E. J.) & Rathburn jr. (C. B.). **A Progress Report on Dosage Tests with Mosquito Adulticides.**—*Mosq. News* **17** no. 3 pp. 190–194, 3 figs., 4 refs. Albany, N.Y., 1957.

What is believed to be a new concept of dosage with aerosols applied under field conditions is discussed, and a progress report is given on tests of insecticide dosage with aerosols against adult salt-marsh mosquitos (*Aëdes taeniorhynchus* (Wied.) and *A. sollicitans* (Wlk.)) in Florida. The usual or "deposit" method of calculating dosage does not give an accurate representation of aerosol applications because it assumes equal distribution or deposit of insecticide on each acre, whereas aerosols drift horizontally and do not settle as do coarse sprays. The insecticide in the aerosol that remains in the air is more important in killing flying insects than the very small amount deposited on the ground. Data, taken from work by A. H. Yeomans, are used to illustrate the results obtained when what is called the "space" method of calculating aerosol dosage is applied. His observations showed that the percentages of droplets deposited in nine successive 100-ft. strips of a 900-ft. swathe from an aerosol with a mass median droplet diameter of 40 μ, derived from a solution containing 7·5 per cent. DDT released at 40 U.S. gal. per hour from a vehicle travelling for a mile at 5 miles per hour across a wind of 3 miles per hour, fell from 7·6 to 1·7 and totalled only 36. By the usual method of calculation, the dosage would be considered to be 0·05 lb. per acre, but when both the amount of insecticide deposited on the soil and the amount that treats the air above each strip is considered, the amount deposited on the first 100-ft. strip being deducted in calculating that available for the second, and so on for each successive strip, the amounts in lb. per acre deposited and airborne per strip ranged from 0·412 lb. for the first strip to 0·271 for the ninth and the average was 0·321. Calculated by the deposit method, the dosage is reduced by half as the swathe width is doubled, which would indicate a substantial decrease in mortality with increased distance. However, in actual tests, malathion gave about 90 and 85 per cent. mortality at 330 and 660 ft., respectively, when used at 0·27 lb. per acre, and nearly 100 per cent. at both distances at 0·54 lb. per acre, and these results accord more closely with the corrected curve of kill at increased swathe widths obtained with the space method.

The two concepts may have an important effect on the interpretation of data already published. The dosage of 15 U.S. gal. per 1,000 linear ft. of an aerosol containing 0·3235 lb. DDT per U.S. gal., recommended by

Brescia [*cf. R.A.E.*, B **36** 83] to control adult salt-marsh mosquitos up to one mile down-wind, represented 0·04 lb. per acre as calculated by the deposit method, but was about 2 lb. per acre according to the space method. It could be concluded from calculations by the deposit method that a modern aerosol generator discharging 5 per cent. DDT at 20 U.S. gal. per hour would apply the same dosage in lb. per acre over a swathe of 330 ft. as Brescia applied per acre over a swathe of one mile. However, calculated by the space method, and assuming a wind velocity of 3 miles per hour, Brescia's dosage over the first 330 ft. of his swathe was 2·08 lb. per acre and the modern machine in this comparison applied only 0·14 lb. per acre over the same swathe. Therefore, Brescia's operation in terms of dosage was equal to 15 of the modern machines moving together down the same street at 5 miles per hour and applying 5 per cent. DDT at 20 U.S. gal. per hour over a swathe of 330 ft. In terms of one small-capacity modern aerosol generator discharging 40 U.S. gal. per hour at 5 miles per hour, a concentration of about 40 per cent. DDT (w/v) would have to be used in order to equal Brescia's true dosage in lb. per acre with a single generator.

Dosage tests with various insecticides against adult salt-marsh mosquitos in Florida were carried out from September 1956 to April 1957 by means of a cage-test technique described elsewhere [see next abstract]. Tests were made between 8 and 11 p.m. under good inversion conditions and at wind velocities of 1–10 miles per hour. A TIFA generator [**35** 128] was used. It discharged 40 U.S. gal. per hour and travelled at 5 miles per hour. The diluent was diesel oil, and malathion at 0·5 lb. per U.S. gal. was used as a standard; this gave a dosage of 0·27 lb. per acre (calculated by the space method) with a swathe width of 660 ft., an average corrected kill of 88 per cent. and a range of 60–100 per cent. Malathion at 1 and 0·25 lb. per U.S. gal. gave average kills of 99 and 60 per cent., respectively. At the dosages used, none of the insecticides other than malathion gave an average corrected kill of more than 50 per cent. These included DDT at 1 lb. per U.S. gal. and Lethane 384 [β-butoxy-β′-thiocyanodiethyl ether], Lethane 384 Special [β-butoxy-β′-thiocyanodiethyl ether and β-thiocyanoethyl esters of higher fatty acids] and Thanite [mainly isobornyl thiocyanoacetate] at dosages recommended by the makers or generally used dosages, and pyrethrins and piperonyl butoxide at a dosage to correspond in cost with malathion at 0·5 lb. per U.S. gal. Although the issue is complicated by resistance, it is thought that there has been considerable underdosing with DDT in aerosol generators.

Rogers (A. J.), Beidler (E. J.) & Rathburn jr. (C. B.). **A Cage Test for evaluating Mosquito Adulticides under Field Conditions.**—*Mosq. News* **17** no. 3 pp. 194–198, 3 figs., 3 refs. Albany, N.Y., 1957.

A description is given of a field technique used in Florida for determining effective dosages of insecticides used in aerosols against adult mosquitos. The aerosols were dispensed from a fogging machine driven along the upwind side of test plots situated in an undeveloped area. Their effect was observed on mosquitos exposed in 14 by 18 mesh wire-gauze cages on poles set up along the dirt tracks of the test area at intervals of 165, 330 and 660 ft., these distances corresponding to one-half, one and two average city blocks; poles were available in all four compass directions, so that the tests could be carried out whatever the direction of the wind. Two cylindrical cages 6 in. long were hung on each pole on brackets 2 and 6 ft. above ground level. Two sets of three poles were used in each test. Larvae and pupae of salt-marsh species of *Aëdes* (*A. taeniorhynchus* (Wied.) and *A. sollicitans* (Wlk.)) were collected from natural breeding places and reared in jars of

a capacity of 1 U.S. pint. The cages, which had a screw cap on one end, were placed vertically with the other end, into which an inverted paper cone had been fitted, over jars containing 50 pupae, so that the newly emerged mosquitos could not return to the water. After 48 hours, the cages were taken from the jars, the paper cones removed, the open ends closed with friction-fitting gauze caps, and pads saturated with sugar-water put on the gauze ends. For tests, the cages were hung horizontally on the brackets. The mosquitos used, which were 2–8 days old, were as far as possible all of the same age in any one test. Ten minutes after the beginning of a test, treated mosquitos were transferred to clean cages and cages of untreated mosquitos hung on the poles for the next test. Treated mosquitos were kept for 12 hours in the open but protected from rain before being examined for mortality. Reproducibility of results was excellent.

Gahan (J. B.). **Further Studies with water-soluble Insecticides for the Control of Mosquito Larvae in Irrigation Water.**—*Mosq. News* **17** no. 3 pp. 198–201, 4 refs. Albany, N.Y., 1957.

Studies on the control of mosquito larvae in irrigation water were continued in pastures in California [*cf. R.A.E.*, B **45** 193] in May 1956 and in rice-fields in Arkansas [*cf.* **45** 4] in July and August 1956. In California, parathion, in the solubilised formulation previously used [**45** 4], was introduced at concentrations of 0·01–0·1 part per million into irrigation water before the water was applied to pastures; this eliminated all larvae of *Aëdes* spp. for $\frac{1}{4}$–$\frac{3}{8}$ mile from the ditches at the heads of the fields, but survivors were found in the lower halves of all fields $\frac{1}{2}$ mile long. A gradual loss in toxicity as the treated water moved across the field was indicated in tests carried out in samples removed from the upper, middle and lower parts of the test plots. *Psorophora* larvae breeding in rice-fields in Arkansas were eliminated completely from areas as large as 10–30 acres with parathion at 0·05 p.p.m., 20 acres with Dipterex [dimethyl 2,2,2-trichloro-1-hydroxyethyl-phosphonate] at 0·5 p.p.m. and five acres with Phosdrin [dimethyl 2-methoxycarbonyl-1-methylvinyl phosphate] at 0·25 p.p.m. The insecticide was applied either where pumps were emptying water into pools or at some constricted point on the route of the water as it flowed from the pools to the fields. All the insecticides except Phosdrin passed through canals ranging in length from $\frac{1}{8}$ to $\frac{3}{4}$ mile before entering the fields through cuts in the canal banks. Phosdrin was introduced into a pool that adjoined the fields. The maximum distance the treated water flowed through the field before any larvae survived 48 hours of flooding was about $\frac{1}{4}$ mile for parathion, 1·8 miles for Dipterex and at least $\frac{1}{2}$ mile for Phosdrin. Parathion lost much of its toxicity in less than a day, and Dipterex failed to give complete control within five days. Factors other than the solubility of the chemical in water obviously control the distance over which the treatments remain effective. Adsorption of the chemical on to soil particles is believed to be important [*cf.* **47** 202]. High water temperature, aeration or pH may also have some adverse effect.

Bidlingmayer (W. L.) & Schoof (H. F.). **The Dispersal Characteristics of the Salt-marsh Mosquito, *Aedes taeniorhynchus* (Wiedemann), near Savannah, Georgia.**—*Mosq. News* **17** no. 3 pp. 202–212, 2 figs., 3 refs. Albany, N.Y., 1957.

The following is substantially the authors' summary. From a release of about two million radioactive adults of *Aëdes taeniorhynchus* (Wied.) near

Savannah, Georgia, in 1954, 428 marked individuals, of which 13 per cent. were males, were recovered. Recapture of females was made at the furthest distances at which traps were situated (18–21 miles). However, most of the radioactive females (90 per cent.) were collected within 4 miles of the release point, the number of recoveries decreasing as the distance increased. Females were observed to bite readily before their departure from the release site, when 12–36 hours old [*cf. R.A.E.*, B **43** 63]. Radioactive males were recovered at maximum distances of 12 miles and for periods of 12–20 days after release. Most of them were recaptured near the release point.

Bacha jr. (W. J.). **The Life History of** *Otobius lagophilus*.—*J. Parasit.* **43** no. 5 [Sect. 1] pp. 560–565, 6 refs. Lancaster, Pa., 1957.

Otobius lagophilus Cooley & Kohls is a North American tick, normally associated only with hares and rabbits [*R.A.E.*, B **28** 245], though it has been recorded from a cat in Alberta [**33** 75]. The apparent infection of this tick with the virus of Colorado tick fever has been reported in the western United States [*cf.* **44** 107] and with the rickettsiae of spotted fever in Mexico. Its life-history was therefore studied in the laboratory as a basis for work on its potentialities as a vector of disease. The study was started with nymphs obtained in March 1955 from *Lepus californicus* in Utah, and subsequent collections were made throughout the spring and summer. *L. californicus* was the most satisfactory laboratory host.

Moulting was accomplished on the host after the larvae had been attached to it for 14–17 days. The interval between initial experimental application of the larva and the natural drop of the engorged nymph varied from 23 to 56 days. This period comprised the parasitic phase, as the adults did not feed. In groups of nymphs, an average of 14·6–24·5 days elapsed between the cessation of their feeding and their moult to the adult stage. The period between pairing and the beginning of oviposition was 6–29 days. Three mated females laid 207, 312 and 655 eggs in 10, 19 and 76 days, respectively. The average incubation period of eggs laid by 24 females was 17·5 days. Unmated females sometimes laid a few eggs, but these did not hatch.

There was only one nymphal stage; the length of the nymphal hypostome appeared to be governed by the degree of engorgement of the larva before moulting, and differences in it did not show an additional moult in the nymphal stage, as Brumpt had indicated, in a paper already noticed [**25** 122], for *O.* (*Ornithodoros*) *megnini* (Dugès), the only other species of *Otobius* known.

Newton (W. L.). **Experimental Transmission of the Dog Heartworm,** *Dirofilaria immitis*, **by** *Anopheles quadrimaculatus*.—*J. Parasit.* **43** no. 5 [Sect. 1] p. 589. Lancaster, Pa., 1957.

Transmission of *Dirofilaria immitis* experimentally from dog to dog exclusively by the bite of an infected intermediate host has seldom been reported. In 1955, some 50–75 infective larvae of *D. immitis* dissected from four females of *Anopheles quadrimaculatus* Say that had fed two weeks earlier on an infected dog were injected into an uninfected dog, born and reared in a cement-floored room in which no mosquitos or fleas had been observed. Microfilariae of *D. immitis* were first observed in this animal in the seventh month after injection, and its blood was still positive for microfilariae 19 months after inoculation. In the autumn of 1956, a dog born and reared in the cement-floored room was exposed to the bites of 55 infected

females of *A. quadrimaculatus* from two lots on five occasions over a period of three weeks. The mosquitos, which appeared to be affected by the infection, seemed to have difficulty in feeding, and only eight were observed to do so. Dissections of these, and of some that did not feed, indicated rather heavy infections; one of those that had not fed had 27 infective larvae in the head and thorax. Monthly examinations showed that the ear blood of the dog remained uninfected for six months; no examinations were made during the next two, but three microfilariae of *D. immitis* were found per 20 cu. mm. blood after nine months and 20 per 20 cu. mm. after ten.

Roth (L. M.) & Willis (E. R.). **The medical and veterinary Importance of Cockroaches.**—*Smithson. misc. Coll.* **134** no. 10 (Publ. 4299), [4+] 147 pp., 7 pls., 26 pp. refs. Washington, D.C., 1957.

In this summary of the extensive published information on the relationship between cockroaches and the agents that cause disease in man and animals, detailed evidence of the natural or experimental association of cockroaches (mainly *Periplaneta americana* (L.), *Blatta orientalis* L. and *Blattella germanica* (L.)) with pathogenic viruses, bacteria, fungi and protozoa, and with the pathogenic helminths of which they have been found to carry the eggs or for which they serve as intermediate hosts, is assembled in appendices. These form the greater part of the work. The text is partly a discussion of this evidence; it includes also sections on allergies attributed to the secretions of cockroaches, on the possibility of their biting man and on the relative importance of cockroaches and house-flies [*Musca domestica* L.] as disease vectors. A list of 18 species of cockroaches that have been shown to transmit pathogenic agents naturally or experimentally or have been claimed to bite man in various parts of the world is given, with very brief indications of the distribution and habits of the less well-known. It is concluded that the potential importance of cockroaches as vectors of disease agents is much greater than is generally supposed.

Papers noticed by Title only.

Doss (M. A.), Humphrey (J. M.) & Segal (D. B.). **Index-catalogue of Medical and Veterinary Zoology. Supplement 8. Authors: A to Z.**—[1+] 337 pp. Washington, D.C., U.S. Dep. Agric., 1958. Price $1.25. [*Cf. R.A.E.*, B **46** 222.]

Mattingly (P. F.). **The Culicine Mosquitoes of the Indomalayan Area. Part III. Genus** *Aëdes* **Meigen, Subgenera** *Paraëdes* **Edwards,** *Rhinoskusea* **Edwards and** *Cancraëdes* **Edwards.**—61 pp., 23 figs., 24 refs. London, Brit. Mus. (Nat. Hist.), 1958. Price 12*s*. **Part IV. Genus** *Aëdes* **Meigen, Subgenera** *Skusea* **Theobald,** *Diceromyia* **Theobald,** *Geoskusea* **Edwards and** *Christophersiomyia* **Barraud** [including extensions to the keys and descriptions of new species in both parts].—61 pp., 24 figs., 44 refs. 1959. Price 12*s*. [*cf. R.A.E.*, B **45** 199; **46** 32.]

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